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# Highway Safety Literature

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**SAE:** Society of Automotive Engineers, Dept. HSL, 400 Commonwealth Drive, Warrendale, Pa. 15096. **Order by title and SAE report number.**

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## **ABSTRACT CITATIONS**



# SAMPLE ENTRIES

## FORMAT OF ENTRIES IN HIGHWAY SAFETY LITERATURE

NHTSA accession number ----- HS-013 174

Title of document ----- **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY MALE AND FEMALE DRIVERS**

Abstract ----- The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) ----- by C. R. VonBuseck

Corporate author (or author's affiliation) ----- General Motors Corp.

Publication date; pagination ----- 1973?; 18p

Supplementary note ----- Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are included.

Availability ----- Availability: Corporate author

NHTSA accession number ----- HS-018 924

Title of document ----- **NATURAL FREQUENCIES OF THE BIAS TIRE**

Abstract ----- The lowest natural frequencies of a bias tire under inflation pressure are deduced by assuming the bias tire as a composite structure of a bias-laminated, toroidal membrane shell and rigorously taking three displacement components into consideration. The point collocation method is used to solve a derived system of differential equations with variable coefficients. It is found that the lowest natural frequencies calculated for two kinds of bias tire agree well with the corresponding experimental results in a wide range of inflation pressures. Results of the approximate analysis show that the influences of the in-plane inertia forces on natural frequency may be considered small, but the influences of in-plane displacements are large, particularly on the natural frequency of the tire under low inflation pressure.

Personal author(s) ----- by Masami Hirano; Takashi Akasaka

Journal citation ----- Publ: Tire Science and Technology v4 n2 p86-114 (May 1976)

Publication date ----- 1976; 6refs

Availability ----- Availability: See publication

## STUDY OF HUMAN IMPACT TOLERANCE USING INVESTIGATIONS AND SIMULATIONS OF FREE-FALLS

A study of free-fall accidents and resulting injuries was conducted to determine usefulness of these types of data in establishing human injury tolerance limits. Objectives were to investigate specific free-falls in sufficient depth to permit biomedical or mathematical reconstruction of the fall, simulate selected free-falls to estimate impact response, and compare predicted responses with observed injuries. From more than 2100 reported free-falls, 110 were investigated on-site. Seven head-first and three feet-first falls were simulated using the MVMA 2-D crash victim simulator. Data showed that males fell six times as often as females and most often at work; children from windows and balconies most often. Children were usually injured less severely than adults under similar conditions, and tended more to land on their heads. For impacts onto rigid surfaces, both children and adults may be expected to suffer skull fractures in head-first falls of greater than ten feet; adults are likely to incur lumbar spine fracture if they land in a sitting position after falling ten feet, and pelvic fracture in feet-first falls of more than 30 feet. The head-first fall simulations predicted skull acceleration responses that were higher than previously considered survivable, though five of the six child subjects whose falls were simulated did survive. Simulation results indicated that for some children under eight years old peak accelerations of as high as 350 G, with a rate of onset of up to 200,000 G/sec and a duration of up to 3 msec (approximately head injury criterion (HIC) 01700-2800) would produce only moderate, reversible injury (as defined by abbreviated injury scale (AIS)2). For this same age group the survival limit for head impacts—the level at which most people would sustain AIS 5 or greater injuries—was estimated to be as high as 600 G peak acceleration and 300,000 G/sec for a duration of up to 3 msec (approximate HIC 0 up to 11,000). The combination of in-depth on-site investigation and computer simulation of representative cases was found to be an effective method of studying impact injury tolerance. Results were in conceptual agreement with published data and could logically be extended to include age groups for which there were no published data. The simulations also predicted higher forces and accelerations than were previously considered to be survivable and thus tentatively support new conclusions regarding human tolerance to impact.

by David R. Foust; Bruce M. Bowan; Richard G. Snyder  
University of Michigan, Hwy. Safety Res. Inst.  
Publ: HS-021 782 (SAE-P-73), "Stapp Car Crash Conference (21st) Proceedings," Warrendale, Pa., 1977 p1-51  
Rept. No. SAE-770915; 1977; 27refs  
Presented at the Conference, New Orleans, 19-21 Oct 1977.  
Availability: In HS-021 782

HS-021 854

## ENGINE OPTIONS FOR THE CAR OF TOMORROW

Predictions as to what engines will power future automobiles are made for the next twelve years, based on available power plants presently available. Three categories of future powerplants include near-term technology features (spark-ignition improvements, stratified-charge, and diesel), advanced

heat engines (gas turbine and Stirling), and stored-power systems (battery-powered cars and hybrids). The present spark-ignition engine will evolve into a sophisticated powerplant. Replacement of the spark ignition engine will take years after a new engine is in production. Improvements of the present engine include the oxidation catalyst plus air pump system for lower emissions, compression-induced turbulence, and changes in combustion chamber shape for improving thermal efficiency, favorable valve timing for part-load efficiency, intake-manifold improvements for superior fuel/air mixture and more uniform distribution, electronically controlled fuel-injection systems, advanced carburetors for better fuel/air ratio control, and microcomputer control of engine variables. The stratified charge and diesel engines provide reliability, short-term reductions in emissions and fuel consumption, and require less research and development costs than more revolutionary alternatives since existing tools, facilities and know-how can be used. The stratified-charge engine, using diesel-type fuel injection, provides better fuel economy than with a conventional carburetor at present emissions levels, but future emissions controls will necessitate more complex and costly modifications. The diesel engine provides better fuel economy and lower hydrocarbon and carbon monoxide emissions, but has drawbacks of smoke, odor and noise, difficult starting, high initial cost and weight, and poor performance. The use of a prechamber reduces noise, but nitrogen oxides controls reduce fuel economy of the prechamber. Advanced heat engines would require new manufacturing facilities and these powerplants are not compatible with existing supply and service organizations. The gas turbine engine has a strong market appeal because of clean exhaust, smooth running, and successful use in aircraft engines, but has failed to meet theoretical expectations. Among the problems are part-load fuel economy, high manufacturing and material costs, and transient response characteristics. The Stirling engine is rated high for fuel economy and low emissions due to superior thermal efficiency. Its continuous-flow burner is easily controlled, it has a tolerance for a wide range of fuels, and is very quiet. Problem areas include mechanical complexity and cost. The energy efficiency of electrical vehicles is not at present greater than that of conventionally powered vehicles when all aspects are considered, but the need to conserve petroleum may dictate the use of electric vehicles. Battery technology needs to be developed for improved weight, performance, and range. Alternate fuels for automobiles include methyl and ethyl alcohol as fuels or as additions to gasoline, fuel from biomass by anaerobic digestion of organic waste (methane) and by bacterial fermentation (ethanol), modified gasoline composition, and hydrogen. Synthetic gasoline and distillate from oil shale and particularly from coal, and "lower quality" fuels could replace gasoline, with a significant saving of energy, resources, and money.

by John D. Withrow, Jr.  
Publ: IEEE Spectrum v14 n11 p57-62 (Nov 1977)  
1977  
Availability: See publication

HS-021 909

## PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES.

# **REPORT NO. 8--MITSUBISHI MODEL 6DS7 DIESEL ENGINE. INTERIM REPORT**

Data from dynamometer tests of the Mitsubishi Model 6DS7 diesel engine to determine fuel consumption and emissions at steady-state engine operating modes are presented in tabular and graphical form. These tests are part of a program being conducted to obtain information on performance characteristics of 23 engines used in automobiles sold in the U.S. in order to estimate emissions and fuel economy for varied engine service and duty. Brake horsepower, torque, and brake specific fuel consumption are shown plotted against engine speed (at full rack conditions). The maximum brake horsepower and torque values quoted in general engine specifications are somewhat higher than those shown here. Fuel rate at various load conditions was repeatable over the entire operating range of the engine. Exhaust emissions of carbon monoxide are shown plotted against power at various engine speeds. The exhaust emission rates of hydrocarbons and oxides of nitrogen are repeatable even at engine speeds below 1500 rpm; the size of the scale is such that the figures do not give this appearance initially. A plot of exhaust stream capacity versus power exhibits a dependence on power that is typical of diesel engines. Repeatability of emission rates, fuel consumption, smoke levels, and engine performance was found to be satisfactory for the purposes of these tests.

by W. F. Marshall; K. R. Stamper  
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003  
Contract DOT-RA-75-10  
Rept. No. DOT-TSC-OST-77-48; BERC/OP-76/33; 1977; 36p  
See also HS-021 910--HS-021 912. Rept. for Jul 1975.  
Availability: NTIS

HS-021 910

# **PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES. REPORT NO. 9--CHRYSLER (1975) 225-CID 1-BBL ENGINE. INTERIM REPORT**

Data from dynamometer tests of a 1975 Chrysler 225-CID, 1-bbl engine to determine fuel consumption and emissions at steady-state engine operating modes are presented in tabular and graphical form. These tests are part of a program being conducted to obtain information on performance characteristics of 23 engines used in automobiles sold in the U.S. in order to estimate emissions and fuel economy for varied engine service and duty. Engine performance, emission, and fuel consumption data show good repeatability. Brake horsepower and torque at wide-open throttle (WOT) conditions for various engine speeds show peak values very close to those quoted in general engine specifications. The minimum value of brake specific fuel consumption at WOT conditions occurs at the same engine speed as peak torque. A slightly lean air/fuel ratio was maintained for each load point below 75% of full power for all engine speeds. Emission levels of carbon monoxide and hydrocarbons (HC) were well controlled through the use of the catalytic reactor except near WOT conditions. The HC emissions seem somewhat irregular in that at three mid-range engine speeds peak values occur at 75% and 90% of full load rather than 100%. Oxides of nitrogen emissions appear to be typical of most gasoline engines using EGR and fuel enrichment for power demand; the peak value occurs near stoichiometric air/fuel ratios and at conditions in which there is little or no EGR. Fuel consumption was found to exhibit

nearly a linear relationship with power. Replicate consumption, emissions, and engine performance data were satisfactory for the purposes of these tests.

by W. F. Marshall; K. R. Stamper  
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003  
Contract DOT-RA-75-10  
Rept. No. DOT-TSC-OST-77-49; BERC/OP-77/3; 1977; 40p  
See also HS-021 909, HS-021 911, HS-021 912. Rept. for Jan-Feb 1976.  
Availability: NTIS

HS-021 911

# **PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES. REPORT NO. 10--CHEVROLET (1975) 250 CID 1-BBL ENGINE. INTERIM REPORT**

Data from dynamometer tests of a 1975 Chevrolet 250-CID, 1-bbl engine to determine fuel consumption and emissions at steady-state engine operating modes are presented in tabular and graphical form. These tests are part of a program being conducted to obtain information on performance characteristics of 23 engines used in automobiles sold in the U.S. in order to estimate emissions and fuel economy for varied engine service and duty. The maximum power output of the engine gave results similar to those quoted in general engine specifications. The maximum torque was found at a slightly higher rpm than specified, but the value quoted in the table was exceeded at the prescribed engine speed. Maximum corrected brake horsepower, maximum corrected torque, and brake specific fuel consumption (BSFC) are plotted as a function of engine speed at wide-open throttle (WOT). The minimum BSFC values are found in a range of 90% to 75% of maximum power for any engine speed as can be seen in a plot of fuel consumption rate versus power for a given engine speed. The conditions which promote the low BSFC value are thought to be operation at an air-fuel ratio near stoichiometric, little or no exhaust-gas recirculation and slightly advanced spark timing. Emissions of unburned hydrocarbons and carbon monoxide are maintained at low levels except conditions near WOT. Repeatability of emission rates and fuel consumption was satisfactory for purposes of these tests.

by W. F. Marshall; K. R. Stamper  
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003  
Contract DOT-RA-75-10  
Rept. No. DOT-TSC-OST-77-50; BERC/OP-77/4; 1977; 43p  
See also HS-021 909, HS-021 910, and HS-021 912. Rept. for Dec 1975-Jan 1976.  
Availability: NTIS

HS-021 912

# **PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES. REPORT NO. 11--CHRYSLER (1975) 318-CID 2-BBL ENGINE. INTERIM REPORT**

Data from dynamometer tests of a 1975 Chevrolet 318-CID, 2-bbl engine to determine fuel consumption and emissions at steady-state engine operating modes are presented in tabular and graphical form. These tests are part of a program being conducted to obtain information on performance characteristics

teristics of 23 engines used in automobiles sold in the U.S. in order to estimate emissions and fuel economy for varied engine service and duty. Engine performance, emission, and fuel consumption data show good repeatability. Wide-open throttle (WOT) performance results show peak, brake horsepower, and torque values in excess of those quoted in general engine specifications. The minimum brake specific fuel consumption (BSFC) values at WOT are found at nearly the same engine speed as the maximum torque. Air-fuel ratio was maintained at nearly a constant value except near WOT conditions. Emissions of carbon monoxide (CO) and unburned hydrocarbons (HC) were well controlled at all modes associated with slightly lean air/fuel ratio operation as a result of the catalytic reactor. Maximum levels of nitric oxides emission occurred typically at 90% of full load; this could be associated with the deactivation of the EGR system and an air/fuel ratio near stoichiometric. Fuel consumption was found to be nearly a linear function of power except for low engine speeds. Repeatability of emission rates, fuel consumption, and performance data was satisfactory for the purposes of these tests.

by W. F. Marshall; K. R. Stamper  
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003  
Contract DOT-RA-75-10  
Rept. No. DOT-TSC-COST-77-51; BERC/OP-77/5; 1977; 43p  
See also HS-021 909-HS-021 911. Rept. for Nov-Dec 1975.  
Availability: NTIS

HS-021 913

#### **1975 CRC [COORDINATING RESEARCH COUNCIL] FUEL RATING PROGRAM: ROAD OCTANE PERFORMANCE IN 1975 MODEL CARS**

Results are presented for the ninth in a series of studies (began in 1963) to evaluate the effects of fuel variables on road antiknock performance in current model cars, this series in 1975 model cars. Unleaded gasoline became a requirement with the introduction of catalytic-converter equipped cars in 1975, and unleaded gasolines were used exclusively in the fuel design for these studies. A 13-fuel Box-Behnken design set was used. Twelve of these fuels comprised a fractional factorial design to investigate the independent variables of motor octane number (MON), sensitivity (RON (research octane number)-MON), and volume percent aromatics (AROM) at three levels each. The thirteenth fuel was a centerpoint fuel (CPF) included as a check on linearity of road octane number response to the design fuel variables. Three RMFD full-boiling range fuels used in the 1975 CRC Octane Number Requirement Survey and five unleaded commercial fuels were also evaluated. Full-throttle modified Uniontown road octane ratings (MUON) were obtained in 37 cars of 22 different makes and models by nine participating laboratories. Part-throttle modified Uniontown road octane ratings were obtained in 11 cars of nine different makes and models by four participating laboratories. The data were analyzed by multiple linear and quadratic regressions in order to examine the effects of fuel design variables, as well as nondesign variables on MUON ratings. Analysis of variance was used to investigate the overall contributions of fuel differences, car laboratory differences, and test error to the variability in observed MUON ratings. Of equation forms containing linear terms only, the equation model containing both RON and MON was found to provide the best prediction of full-throttle MUON. Of the two variables, MON is the more important predictor. Inclusion of AROM and/or olefin (OLEF) contents

of the fuels with RON and MON did not improve the prediction accuracy of the full-throttle MUON data. The equation model containing RON, MON, and MON to the second power had the lowest standard error (0.19) of any of the equation forms investigated. Multiple linear regression analyses of the part-throttle MUON data showed that for individual cars MON is the most important predictor of part-throttle MUON, inclusion of RON with MON in general gave only marginal improvement in prediction accuracy, and AROM and/or OLEF terms were not significant in most cases at the 95% confidence level. The analysis of variance showed the designed differences in the fuels accounted for most of the variability (56%). The car-to-car differences (which also include the lab-to-lab differences) were also large (32%). The other sources of variability were small.

Coordinating Res. Council, Inc., Road Rating Analysis Panel,  
30 Rockefeller Plaza, New York, N.Y. 10020  
Rept. No. CRC-494; 1977; 163p  
See also HS-021 914 and HS-021 915.  
Availability: Corporate author

HS-021 914

#### **1975 CRC [COORDINATING RESEARCH COUNCIL] CUSTOMER/RATER KNOCK PERCEPTION STUDY**

Results are presented of a cooperative study to determine the difference between octane requirements of cars measured by raters using the CRC (Coordinating Res. Council) technique, and those reported by customers in unprompted response to a questionnaire. Results are presented as follows: the distribution of octane requirements measured by raters compared to the distribution of octane requirements as reported by customers, and the distribution of differences between octane requirements of raters and customers determined in the same car. Requirements were determined at both full throttle and part throttle when possible. Rater/customer differences were much smaller for requirements determined at part throttle than at full throttle; however, responses indicated that customers observed part-throttle knock in only 39 cars (20%). A few customers appeared to be more sensitive to knock than were the raters, and 14% of the customers did not object to knock when operating on the lowest octane quality (80.6 RON (research octane number)) in the program. The average differences between customer perception and objection octane requirements were about 0.8 RON and 0.6 MON (motor octane number). The average difference between rater and customer requirements for individual cars varied from 1.1 to 8.5 RON among participating laboratories. The differences between rater and customer octane requirements were not related to vehicle engine size, transmission type, deposit miles, or customer age or sex.

Coordinating Res. Council, Inc., Customer/Rater Knock Perception Study Group Analysis Panel, 30 Rockefeller Plaza, New York, N.Y. 10020  
Rept. No. CRC-492; 1977; 156p 3refts  
See also HS-021 913 and HS-021 915.  
Availability: Corporate author

HS-021 915

# 1976 CRC [COORDINATING RESEARCH COUNCIL] OCTANE NUMBER REQUIREMENT SURVEY

Results are presented of the 20th annual statistical survey of current model cars to determine maximum octane number requirements under full-throttle and part-throttle operating conditions and presence of surface ignition knock and rumble. Data were submitted on 450 1976 model cars (408 U.S. and 42 imported models). Requirements for all 1976 cars were 1.2 octane numbers higher than the 1975 models on primary reference fuels (PR) at the 50% car satisfaction level. On full-boiling range unleaded fuels (FBRU), research octane number (RON) requirements were 1.8 octane numbers higher than on 1975 models at the 50% car satisfaction level, and 1.8 octane numbers higher on motor octane (MON) requirement basis. On full-boiling range high sensitivity unleaded fuels (FBSU), RON requirements were 1.4 octane numbers higher than on 1975 models at the 50% car satisfaction level, and 1.3 octane numbers higher on a MON requirement basis. The speed for maximum knock occurred between 1600 and 2800 rpm for 83% of all cars with PR fuels, 74% with FBRU fuels, and 65% with FBSU fuels. Incidence of part-throttle knock was slightly higher in 1976 model cars as compared to 1975 model cars. Maximum requirements occurred at part throttle in 4.4% of all 1976 model cars with PR, 17.7% with FBRU, and 24.8% with FBSU. In the 1976 survey, 47% of the weighted car population (in proportion to 1976 car model production figures for U.S. cars, and in proportion to sales data in the U.S. for imported models) was found to knock on tank fuel compared to 38% in the 1975 survey. There were 11 reports of after-run on tank fuel. There were three reports of cars with surface ignition knock as compared to nine in the 1975 survey. Two occurred with knock. Rumble was not observed in any of the cars tested. Road octane number depreciation varied from 0.4 to 5.6 with FBRU fuels and from 1.1 to 6.0 with FBSU fuels. Maximum octane number requirements at 50% and 90% satisfaction levels occurred between 2100 and 2150 rpm. A spread of about 4.5 octane numbers existed across the speed range between the highest and lowest requirements at all satisfaction levels. Maximum requirements with FBRU fuels were observed in highest gear with 80% of the cars tested, in passing gear with 17%, and were the same in both gears with 1%. In the remaining 2%, 1% of the requirements were less than the lowest FBRU fuel available and 1% were greater than the highest FBRU fuel.

Coordinating Res. Council, Inc., Octane Number Requirement Survey Group Analysis Panel, 30 Rockefeller Plaza, New York, N.Y. 10020  
Rept. No. CRC-493; 1977; 20pp  
See also HS-021 913 and HS-021 914.  
Availability: Corporate author

HS-021 917

## P/M FORGING SUCCESSES

The technology development of powder metallurgy (P/M) forging is reviewed, and the successful commercial applications of this process are described. P/M forging, introduced with much fanfare in the early 1970's, has overcome its initial technical problems and is beginning to achieve its early promise of significant economic savings. The development of the forging process is discussed in terms of heating the preform, handling the hot preform, lubrication, tool materials, tolerances, preform design, properties of P/M forgings, the early 70's

decline, and P/M forging today. The P/M forging process has been successful for automotive parts, farm equipment, hydraulic pumps and motors, outboard motors, chain saws, and industrial hand tools. With respect to the future, the process has capabilities to readily produce configurations that are difficult or impossible by conventional machining methods. Proper application of the process can provide and has provided substantial economic advantages. With acceptance and proven performance gaining ground in many varied industries, increased use of the P/M forging process is readily predictable.

by A. J. Ashley  
Burgess-Norton Mfg. Co., Res. and Dev. Engineering  
Rept. No. SAE-770099; 1977; 12p Srefs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 925

# CHARGE-DISCHARGE BEHAVIOR OF THE C.G.E. [COMPAGNIE GENERALE D'ELECTRICITE] CIRCULATING ZINC-AIR VEHICLE BATTERY

The technical aspects of recharge of the C.G.E. circulating zinc-air vehicle battery are discussed. The primary unit of the C.G.E. [Compagnie Generale d'Electricite] zinc-air battery consists of a constant cross-section tubular fuel cell using zinc powder in circulating 12 N KOH (potassium hydroxide) solution. All the reaction product (zincate) is maintained in colloidal solution. The system is capable of lifetimes in excess of 1800 hours and will be of low cost. In contrast to the primary cell, the recharge of the system is still in the laboratory engineering stage. The circulating zinc-air battery, in either internally or externally charged forms, is capable of an appreciably lower cost per km than a vehicle with an advanced lead-acid battery. In addition, in its externally charged form it is capable of rapid refueling, giving better user convenience. While its efficiency is only (at best) about two thirds that of lead-acid or nickel-zinc batteries, its amortized cost per kilometer is comparatively low (48%-80% higher than that of a gasoline motor including its necessary maintenance). Even lower zinc-air amortized costs are probably possible, since the system auxiliaries (motors and pumps) have been costed in this study at much greater values than are used for mass-production automobile components. Eventual per km amortization costs may be 20% lower than those quoted. Regarding energy efficiency, using a 55% coal-to-synthetic-hydrocarbon conversion efficiency, overall energy efficiency for a synthetic gasoline vehicle with respect to coal will be 10.1%; the figure for the zinc-air vehicle (40% conversion efficiency coal-electricity, 10% transmission line losses) will be 40% higher. Eventually, if hydrogen can be produced from coal at 60% efficiency, it is possible to envisage external recharge of the zinc-air system with hydrogen-depolarized anodes functioning at an overall potential of 0.70 V. Including all losses (shunt currents, auxiliaries, faradaic inefficiencies), the overall energy efficiency based on coal (using the above figures for conversion efficiency and electrical transmission line losses) would be 21.5%, comparable to that of present or proposed conventional traction battery vehicles.

by A. J. Appleby; J. Jacquelin; J. P. Pompon  
Laboratoires de Marcoussis, France  
Rept. No. SAE-770381; 1977; 12p Trefs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 931

# **APPLICATION OF THE FORD SODIUM-SULFUR BATTERY IN ELECTRIC VEHICLES**

The power and energy requirements of sodium-sulfur batteries in electric vehicle applications have been evaluated. For an electric passenger car with a gross weight of 1134 kg (2500 lbs) and with a four-speed transmission, a battery power capability of approximately 44 kw is required to assure a vehicle acceleration capability equivalent to that of a conventional vehicle of the same weight. To obtain a driving range in urban traffic of 161 km (100 mi), a battery energy capability of approximately 33 kwh is required if regenerative braking is used. The improvement in vehicle acceleration resulting from the use of a four-speed transmission and the range increase resulting from the use of regenerative braking suggest their use. The thermal management of sodium-sulfur batteries is especially important and requires high quality thermal insulation to retain heat within the battery package during normal driving and some cooling to remove heat during periods of driving requiring peak battery power. The conducting straps that connect individual cells within the battery package can result in a significant power loss at peak power conditions, reducing the power capability of the battery. Additional effort is required to provide acceptable compromises among the loss components, heat transfer requirements, and the total package size and weight.

by L. E. Unnewehr; R. W. Minck; C. Owens  
Ford Motor Co., Engineering and Res. Staff  
Contract NSF-C805  
Rept. No. SAE-770382; 1977; 11p 14refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 946

# **COST OF FUELS FOR FUEL CELL AUTOMOBILES**

The relative overall cost to the consumer of several promising candidate fuels for fuel cell/battery hybrid electric automobiles in the decade around 2000 AD is projected. The costs have been estimated in terms of the cost and energy efficiency of the entire sequence of processing steps from energy raw materials to energy delivered at the wheels/road. A comparison among roughly equivalent i.e.e. (internal combustion engine), battery, and fuel-cell cars is included, together with a brief review of the effects of increasing cost of crude oil and other energy resources on the operating cost of the three types of automobiles. Two of the candidate fuels would be expected to be used in direct-oxidation cells, viz. LPG and methanol. Three other fuels, nonleaded gasoline and specially hydrotreated (sulfur and nitrogen-free) naphtha and kerosene, are expected to be first subjected to steam reforming in a small, on-board converter, to generate a "dirty" hydrogen containing carbon oxides, which would be then fed to a hydrogen fuel cell. The carbon monoxide present in the fuel cell effluent would presumably then be burned to provide heat for the reforming reaction. Water and carbon dioxide would be the only combustion products in the automobile exhaust. The projected cost of each of the fuel-cell fuels examined is less than two times the projected cost of unleaded gasoline, on an energy content basis. The high cost of the most expensive fuel, LPG (liquefied petroleum gas), is in large measure due to anticipated high distribution cost resulting from high vapor pressure. Thus, any of the fuels studied could be attractive for use in fuel-cell cars. The estimated overall cost of ownership

and operation of fuel-cell cars appears to be at least competitive with cost of battery and i.e.e. cars. Moreover, depending on the choice of certain important premises concerning design and maintenance (assumption of nonreplacement of fuel cell), the fuel-cell car could be significantly less expensive to own and operate than the i.e.e. or battery car. As a nonpolluting car for urban/suburban operation, the fuel-cell car appears to be preferable to the battery-powered car, on the basis of estimated total costs of ownership and operation. Furthermore, fuel-cell cars are more fuel efficient; and, therefore, the cost of their operation is likely to be influenced less by rising energy cost and they would consume less energy resources. Finally, the higher efficiency/lower fuel consumption expected for the fuel-cell car may make it attractive despite its higher estimated initial cost compared to the i.e.e. car.

by Warren V. Bush  
Shell Devel. Co.  
Rept. No. SAE-770380; 1977; 16p 28refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 947

# **AUTOMOBILE INSURANCE LOSSES, COLLISION COVERAGES; A COMPARISON OF COLLISION CLAIM SIZE DISTRIBUTIONS FOR 1974, 1975, AND 1976 MODELS**

Collision coverage claim size distribution data for 1974, 1975, and 1976 cars are broken down by car size, body style, and age. Subcompact consistently have the largest of claims over \$500, \$1000, and \$2000; full-size cars consistently have the smallest percentages of claims over these amounts. Among cars of the same size, sports and specialty models more frequently have larger claims than other models, and two-door models more frequently have larger claims than corresponding four-door models. The frequencies of large collision coverage claims increase with both model year and car age. The differences in the sizes of collision claims generated by different cars chiefly affect their average claim sizes rather than the shapes of the distribution of claims. During the first year of availability, the average claim payment was \$534 for 1974 models, \$634 for 1975 models, and \$659 for 1976 models. The average claim payment increased to \$567 for 1974 models in their second year of availability and to \$601 in their third year.

Highway Loss Data Inst., Watergate 600, Washington, D.C. 20037  
Rept. No. HLDI-A-9; 1977; 39p 3refs  
Availability: Corporate author

HS-021 948

# **EFFECTIVENESS OF AUDIBLE WARNING DEVICES ON EMERGENCY VEHICLES. FINAL REPORT**

The effectiveness of audible warning devices (AWD's) on emergency vehicles in terms of aural detectability was examined, and community noise intrusion and opportunities for AWD optimization were investigated. The study concentrated upon the following three parts of the detection process: source (siren), path (distance and structures), and receiver (the human detection process in the presence of noise). Measurements were made of sirens, automobile insertion loss, and human detection performance in real-life and simulated situations.

Warning effectiveness distances were calculated for the following three representative situations: rural environment with vehicle windows closed and radio on, urban environment with vehicle windows open and radio off, and suburban environment with vehicle windows open and radio off. It was concluded that reliance on present AWD's to warn drivers in traffic is not justified. To be loud enough to warn in all ordinary circumstances, the sound level of AWD's would have to be increased greatly, producing intolerable community noise. During emergency-vehicle driver training, drivers should be taught about the short detection distances commonly encountered. Present AWD's can be improved; more uniform horizontal forward radiation and higher frequency sounds would increase detectability. This analysis procedure can provide the basis for an objective measure of AWD performance. Such a performance measure could be incorporated into a recommended practice.

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Warrendale, Pa. 15096; Bolt, Beranek and Newman Inc., 30  
Moulton St., Cambridge, Mass. 02138  
Contract DOT-TSC-868  
Rept. No. DOT-TSC-OST-77-38; 1977; 149p 41refs  
Rept. for Jun 1975-Jun 1976. Subcontracted to Bolt, Beranek  
and Newman Inc.  
Availability: NTIS

HS-021 956

## HUMAN FACTORS IN MOTORCYCLE ACCIDENTS

Data are collected and synthesized for all elements of precrash, crash, and postcrash phases related to environmental, vehicle, and human factors in an on-scene, in-depth multidisciplinary investigation of at least 900 motorcycle accidents and acquisition of at least 3600 police traffic accident reports. Data from the first 300 accidents have indicated that motorcycle conspicuity, rider skill, training and licensing, and protective equipment predominate in accident and injury causation. An important means of increasing motorcycle conspicuity is the daytime use of motorcycle headlamps. Offroad riding of dirt bikes seems to provide the necessary skills in motorcycle operation needed to prevent traffic accidents. There is a general lack of formal or specialized training in these skills, as exists for automobile operation. Braking and turning a motorcycle are complex tasks. Protective equipment for the rider, especially against abrasion, is necessary since the vehicle provides little or no crash protection. Protective helmets are judged to be of vital importance in spite of rider complaints of sound attenuation, limited peripheral vision, rider fatigue, and neck injury on impact. Safety helmets were found to provide a high level of protection against such impacts as tangential abrasion, normal impact, or even crushing loads, where tire marks were observed on the helmets.

by H. H. Hurt, Jr.; C. J. DuPont  
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Contract DOT-HS-5-01160  
Rept. No. SAE-770103; 1977; 8p 7refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 957

## A STYLING HISTORY OF BRIGHTWORK AND ITS EFFECT ON FUTURE MARKETING

The influence is evaluated of the major events in the history of automotive brightwork as it affects the styling of contemporary chrome trim. In the preDepression period, automobiles such as Duesenberg, Pierce-Arrow, Packard, Rolls-Royce, Invicta, Bugatti, Stutz, and Cord had handcrafted, custom coach built bodies featuring chrome trimming. In postDepression times, brightwork accents on production grilles, headlights, taillights, and instrument panels as well as on bumpers became the accepted standard on high-volume, low-price cars. During World War II brightwork succumbed to a shortage of nickel but reappeared after the war to a point of excess in the 1950's. The introduction of safety legislation brought about a change in brightwork design to eliminate protruding trim for passenger protection. New production techniques such as chrome plated plastic, hot stamping, and vacuum metalizing gave designers greater freedom of design at maintained or reduced cost. Present and future trends will be affected by fuel economy and weight reduction constraints. The possibility of chrome-plated aluminum will allow brightwork bumpers to be built within weight allowances. Ideas for "crushable chrome" will be needed to maintain design and marketing trends. In the future, designers will depend on refinement of detail. Quick design change flexibility and durability of brightwork will be needed, since basic automobile design requiring retooling will occur less frequently. A return to the classic use of brightwork as in the 1920's and 1930's is prognosticated, where the trim complements the sheet metal forms and the automobile's function.

by John B. Delphia  
Chrysler Corp. Design Office, Cordoba Charger Exterior  
Design Studio  
Rept. No. SAE-770108; 1977; 12p 8refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 958

## CORROSION BEHAVIOR OF TRIM MATERIALS ON AUTOMOBILES

The mechanisms of corrosion behavior of various exterior automotive trim materials are discussed, including electroplated steel, stainless steel, stainless clad aluminum, and anodized aluminum. Corrosion performance of exterior trim is based on corrosion resistance and appearance of the trim material itself, and the effect of the trim material on the adjacent painted auto-body steel. The performance of chromium plated steel exterior trim depends on the quality of the electrodeposit. Stainless steel has gradually replaced chrome plated steel in many areas because of its inherent corrosion resistance. This type of alloy is susceptible to localized corrosion such as pitting, and crevice corrosion in the presence of chloride. Surface finish has an important effect on the corrosion resistance of stainless steels. The inherent corrosion behavior of aluminum in automobile exterior trim requires that it be anodized. Anodized aluminum trim components become corroded by the etching of the oxide film and by corrosion of the aluminum substrate. The first is caused by such pollutants as sulfur oxides, condensed moisture, soil deposits, and acid or alkaline environments. Alkaline agents in carwash detergents should be avoided. Corrosion of the aluminum substrate results from

discontinuities in the anodized film caused by mechanical forces such as impact by stones or door bumping. Corrosion resistance increases with increasing anodic film thickness, although this can increase susceptibility to crazing. Stainless steel in galvanic couple with painted auto-body steel causes accelerated corrosion of the latter at paint damage sites. Attempts have been made to reduce this corrosion by breaking the electric or electrolytic continuity between the two metals, and by introducing a metal which is more active than steel in the galvanic series. Use of an insulating material such as plastic clips has been found to be impractical. Breaking the electrolytic continuity by improving the paint quality will not reduce the damage caused by stone impingement or the like. Use of a metal more active than auto-body steel, such as anodized aluminum or stainless clad aluminum, has provided a practical solution. Research on stainless clad aluminum exterior trim has been confirmed by six years of in-service performance experience.

by Robert Baboian  
Texas Instruments Inc.  
Rept. No. SAE-770110; 1977; 12p 34refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 959

## WHAT STAINLESS STEEL OFFERS THE MODERN WHEELCOVER

Characteristics of Type 301 stainless steel and their role in the design and manufacture of automotive wheel trim are described. Type 301, developed primarily for wheelcovers, is an austenitic chromium-nickel steel capable of attaining high tensile strength and ductility by moderate or severe cold working. It is used largely in the cold-rolled or cold-drawn condition in the form of sheet, strip, and wire. Type 301 is essentially nonmagnetic, but it becomes magnetic when cold worked. Chromium is chiefly responsible for the corrosion resistant properties of this stainless steel. When stainless steel is exposed to oxygen, such as in air or aqueous environments, a hard, tenacious, but invisible chromium oxide film forms on the metal surface. This film resists abrasion and corrosion in environments to which a wheelcover is exposed. As well as can be determined, no wheelcover has ever needed replacement because of corrosion failure. The presence of 6%-8% nickel in Type 301 serves to enhance corrosion resistance, and it also contributes to the excellent mechanical properties and fabrication characteristics of the stainless steel. In addition to the description of Type 301, data are provided on deep drawing and press forming of the stainless steel, which are involved in wheelcover manufacturing; and comparisons are made of Type 301 with aluminum alloy 5252-H25 which is being considered for wheelcovers. The aluminum alloy has a very narrow range between yield and tensile strengths, and has low (11%) elongation. Its hardness is only about half that of Type 301, and its anodized coating is extremely hard and brittle.

by E. S. Kopecki  
American Iron and Steel Inst., Com. of Stainless Steel  
Producers  
Rept. No. SAE-770111; 1977; 10p  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 960

## A FIVE-CYLINDER ENGINE AS AN ECONOMICAL, SMOOTH-RUNNING POWER PLANT

The development of AUDI NSU's five-cylinder, in-line gasoline engine for production cars is described. The engine is designed to run at speeds up to about 7000 rpm and to provide smoothness, flexibility, and economy with the advantages of front wheel drive. The engine is an extension of a 1.6 liter, four-cylinder engine, components of which it shares: all valve gear components with the exception of the lengthened camshaft and enlarged valves; conrods with bearing shells and bolts, piston pins and rings; timing belt sprockets; shaft seals; and thermostat. New design features include the following: omission of the jack shaft driving the oil pump, distributor, and fuel pump; oil pump driven directly off the camshaft and the distributor mounted on the cylinder head and driven directly off the camshaft; a bypass channel added to the oil pump; and integration of the water pump and the thermostat housing in the engine block. Other new features include the following: omission of a tensioning roller; increase of engine stroke to 86.4 mm; lengthening of steel crankshaft; and modification of combustion chamber design. The compression ratio of the European version is 9.3:1. A cylindrical collector chamber with a capacity of about 1.8 liter and 270 mm long intake ducts was chosen, as was a Bosch K-Jetronic fuel injection system with injector valves and a breakerless transistorized ignition system. The engine/transmission assembly was stiffened. The U.S. version has a compression ratio of 8.0:1 and a special lean mixture setup. Power and torque curves are graphed for both versions. Exhaust emission levels of the Federal and California versions are listed; these versions have 17-19 mpg city and 24-27 mpg highway.

by Franz Hauk; Werner Dommes  
AUDI NSU Auto Union AG, Ingolstadt, Germany  
Rept. No. SAE-770112; 1977; 12p 3refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 961

## ADVANCED AUTOMOTIVE POWER SYSTEMS. PT. 2: A DIESEL FOR A SUBCOMPACT CAR

The development of a diesel engine for subcompact cars by the VW Passenger Car Diesel Engine Proj. is described, and the extent to which the Project was able to attain its objectives discussed. It was the goal of the project to meet the challenges of the future, and to combat rising fuel prices and environmental pollution. To attain this goal, some of the ill-famed diesel disadvantages, such as noise, smell, smoke, and slow acceleration, the latter as a result of the low horsepower-to-weight ratio, had to be alleviated. On the other hand, it was intended to preserve for subcompact car use the classical diesel advantages, such as excellent fuel economy, long service life, low incidence of malfunctions, and favorable emissions. In addition to meeting worldwide requirements, compliance with U.S. emission regulations was especially intended. Compared to a spark ignition engine of the same power output, it was intended to improve the fuel economy of the diesel by 30% to 50% and its service life by more than 50%. Another objective was to keep diesel production cost low by using the largest possible number of spark ignition engine parts for diesel production. Of all diesel operating principles, the swirl chamber design was found to comply best with manifold



requirements connected with a subcompact car. By virtue of extensive development work on the spark ignition engine parts, both types of engines can be produced on the same transfer line.

by P. Hofbauer; K. Sator  
Volkswagenwerk AG, Germany  
Rept. No. SAE-770113; 1977; 48p 11refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 962

## A VARIABLE-DISPLACEMENT SPARK-IGNITION ENGINE

A five-cylinder variable displacement research engine has been designed, built, and tested for over one year. Displacement is varied by changing the piston stroke using a four-bar linkage. By proper choice of the linkage dimensions, compression ratio can be held constant as the stroke changes, or it can be tailored to optimize economy and performance. Before the engine was built, its dynamics were thoroughly analyzed, and a five-cylinder configuration was selected to minimize vibration. Over 130 hours of running time have been accumulated to date, mostly in the range of loads and speeds encountered in typical driving situations. Engine dynamometer tests have resulted in data on power, fuel consumption, and emissions. The data show that BSFC (brake specific fuel consumption) is, as expected, less dependent on load than in conventional engines, and averages less than 0.5 lb/bhp-hr over the load and speed range of ordinary automobile operation. Data and analysis indicate that this type engine may improve EPA (Environmental Protection Agency) urban cycle gasoline mileage 25% to 40% over 1976 automobiles in the 3500 pound inertial weight class. Allowance must be made for the fact that emissions have not yet been controlled in this engine. Durability has been demonstrated in the dynamometer testing, with no measurable wear of the connecting rod bearings, crankshaft, cylinders, or pistons. It remains to be seen if this engine concept will be durable enough for the American family car and whether the fuel economy projections can be realized during in-vehicle operation at statutory emissions levels.

by H. N. Pouliot; W. R. Delameter; C. W. Robinson  
Sandia Labs.  
Contract AT-(29-1)-789  
Rept. No. SAE-770114; 1977; 22p 11refs  
Presented at International Automotive Engineering Congress and Exposition, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 963

## INCIDENTS CAUSED BY VEHICLE DEFECTS--ANALYSIS OF THEIR CHARACTERISTICS

Data from in-depth investigations of 1087 incidents caused by vehicle defects reported to an automobile insurer were examined, compiled into various categories, and analyzed. Significant results were that 530 (49%) of the incidents involved vehicle fuel system failures which caused fires. Brake system failures accounted for 301 of the remaining 557 incidents. Recall campaigns, upgrading of vehicle service facilities, and vehicle owner education are recommended. The cost-effectiveness of mandatory periodic motor vehicle inspection systems is questioned. Further research, generally on vehicle safety de-

fects and specifically on the causes of vehicle engine fires, is recommended. Cooperation between the National Hwy. Traffic Safety Administration and auto insurance organizations should be promoted.

by Michael R. Appleby; Louis J. Bintz; Paul E. Keen, Jr.  
Automobile Club of Southern California  
Rept. No. SAE-770115; 1977; 11p 15refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 964

## INSPECTION, DEFECT DETECTION, AND ACCIDENT CAUSATION IN COMMERCIAL VEHICLES

Effects of proper commercial vehicle identification and maintenance procedures on safety were studied, and the need was shown for improved or modified inspection and maintenance requirements in the Federal Motor Carrier Safety Regulations (FMCSR) Section 396, Inspection and Maintenance. An identifiable relationship was shown to exist between good commercial vehicle inspection and maintenance practices, and a reduction in defect-related accidents. The better maintenance practices were usually associated with larger firms, and poorer maintenance practices with smaller firms or individual owner operators. Vehicles should receive a thorough pre-trip inspection, responsibility resting with the driver but accomplished by driving through a checklane or by utilizing an inspector in a careful walkaround with a checklist. The written record of this inspection should be carried in the vehicle, and could be audited by the Bureau of Motor Carrier Safety (BMCS); other evidence of inspection and maintenance activities should also be available in the vehicle. The BMCS should also develop a management program based on data available from the collection of their Safety Accident Report form MCS-63, to prepare reports of enforcement activity by region and for the U.S. generally, on types of vehicle defects by several independent variables, such as make, model, year, region, etc., to prepare reports and notifications to companies and manufacturers on frequent defects, and activity reports for field management personnel. These data would be of more value if a set of data were collected on an unbiased sample of the truck population periodically, for comparison. To communicate with smaller firms, increasing their awareness of BMCS regulations and knowledge of sound safety practices, instructional materials could be provided at truck stops, weigh stations, or included in state licensing examinations (for those states with classified driver's licenses).

by Thomas L. McDole  
Highway Safety Res. Inst.  
Rept. No. SAE-770116; 1977; 12p 6refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. Based on a Hwy. Safety Res. Inst. study, "Effects of Commercial Vehicle Systematic Preventive Maintenance on Specific Causes of Accidents."  
Availability: SAE

An accident investigation study emphasizing the role of vehicular factors in causing accidents was based on data from Monroe County, Ind., where, between 1970 and 1975, 2258 accidents were investigated by teams of technicians using a consistent set of procedures and terminology. Concurrently, 420 in-depth investigations were conducted by a multidisciplinary team. Vehicular degradations, maladjustments, and failures were identified as definite causes in 4.5% of these accidents by the multidisciplinary team, and in 4.1% by the technicians. Vehicular problems were considered either definite or probable causes in 12.6% of these accidents by the in-depth team, and in 9.1% by the technicians. Problems with brakes and tires predominated as vehicular causes, with gross brake system failure side-to-side imbalances, inadequate tread depth and under-inflation among the leading problems identified. It is recommended that states continue efforts to improve inspection procedures, with emphasis on detection of brake problems. Vehicle causation problems should continue to be monitored periodically, as the continual introduction of mechanical innovations will affect the involvement of various vehicle systems, requiring periodic readjustment of inspection items and programs. Brake failures should show a gradual reduction through the effects of the dual-chamber master cylinder and of disc brakes.

by John R. Treat; Rickey L. Stansifer  
Indiana Univ., Inst. for Res. in Public Safety  
Contract DOT-HS-034-3-535  
Rept. No. SAE-770117; 1977; 19p 11refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 966

#### **THE INFLUENCE OF COMBUSTION WITH PRESSURE EXCHANGE ON THE PERFORMANCE OF HEAT BALANCED INTERNAL COMBUSTION ENGINES**

The heat balanced or combined cycle engine with time-dependent combustion sustained by two-chamber geometry is demonstrated experimentally. Evidence of time dependent heat addition is given where combustion creates a field of pressure waves sustained by pressure exchange between two chambers. The basic cycle and operating characteristics of the Naval Academy Heat Balanced Engine (NAHBE) are reviewed and experimental results with combustion fuel research (CFR) and glass-walled engines demonstrate the engine characteristics compared to those of OTTO engines. Performance evaluation included the following parameters: fuel/cycle, total output, brake output, specific fuel consumption, and revolutions per minute. Improvements in thermal efficiency over the OTTO engine in excess of 45% are demonstrated in some operating regimes. Fuel consumption of the NAHBE engine equals the best performance of the OTTO and is generally lower. Con-

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Availability: SAE

HS-021 967

#### **TRANSIENT RESPONSE OF TURBOCHARGED DIESEL ENGINES**

Two methods are discussed for reducing turbocharger lag: by air injection onto the compressor rotor, and by oil injection onto a small pelton wheel mounted on the turbocharger shaft. Air injection onto the compressor rotor was through three equispaced nozzles drilled into the compressor cover. The effect of air injection on compressor performance was investigated on a steady flow test rig. The modified turbocharger was then fitted to a Ruston and Hornsby 6YEX diesel engine, and the effect of air injection on transient performance was evaluated. The results are presented for both steady state and transient tests; the transient values are in good agreement with computer predictions. The method of assisting turbocharger performance by injecting high pressure oil onto a pelton wheel fitted to the rotor was evaluated on the steady state rig before it was tested dynamically on the engine test bed. Besides the turbocharger modifications both systems require additional equipment to be fitted to the engine. Air injection requires approximately double the amount of compressed air that is normally available from an air brake compressor; this would mean a larger capacity compressor and an additional air brake storage bottle. Use of higher pressures would require a more sophisticated compressor. Pelton wheel assistance requires the fitting of a high pressure hydraulic pump and a high pressure reservoir. Both of the techniques improve the transient performance of the engine. The air injection system is more effective than the pelton wheel and is favored by the authors. It also requires less turbocharger modification than the pelton wheel and compressed air is more generally available in most applications. Computer modeling can be used, in conjunction with steady state rig test results, to predict the effect of applying either technique to the engine. A simulation study of a turbocharged diesel engine installed in a 32 tonne truck is presented to investigate the engine performance during load and speed changes. By injecting compressed air on to the turbocharger compressor rotor tip, smoke emissions from the engine during load changes are reduced. The size of air compressor and receiver required for air injection is the same order as for a conventional truck air braking system. Some preliminary engine tests on a computer-controlled test bed confirm the simulation modeling and results.

by D. E. Winterbone; R. S. Benson; A. G. Mortimer; P. Kenyon; A. Stotter  
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Rept. No. SAE-770122; 1977; 28p 24refs  
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and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 968

# **A NON-LINEAR DIGITAL SIMULATION OF TURBOCHARGED DIESEL ENGINES UNDER TRANSIENT CONDITIONS**

A nonlinear mathematical model has been developed to predict the transient response of a turbocharged diesel engine. The quasisteady "filling and emptying" concept has been employed in the analysis of the thermo and fluid dynamics under transient engine conditions. In addition, by continuously evaluating the dynamic interactions of engine components, major limitations of previous linear and quasilinear models have been overcome. Account is taken of the intermittent nature of processes occurring within the engine, the nonlinear influence of the combustion process on the torque developed and the exhaust-gas energy available at the turbine, the pulsating nature of gas flow, including reverse flow, the effects of manifold volume and design, and the influence of instantaneous manifold pressure on pumping work and its dependence on turbocharger match. A computer controlled testbed and high speed data logging system has been used to acquire detailed data under transient conditions (e.g. injection and cylinder pressure diagrams). These data have been used to validate the model, the result being good agreement between predicted and measured engine performance. Application of the model has proved its value in the study and optimization of design variables which affect engine performance and response time. As examples, the effects of using a fuel pump rack limiter and that of retarding the turbocharger in conjunction with an exhaust waste gate are presented.

by Neil Watson; Maged Marzouk  
Imperial Coll. of Science and Technology  
Rept. No. SAE-770123; 1977; 20p 28refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. Work conducted under auspices of Procurement Executive, Ministry of Defence (United Kingdom), Military Vehicle and Engineering Establishment.  
Availability: SAE

HS-021 969

# **A WHOLLY DYNAMIC MODEL OF A TURBOCHARGED DIESEL ENGINE FOR TRANSFER FUNCTION EVALUATION**

The previous methods of modeling the transient response of turbocharged diesel engines are reviewed, emphasizing their dependence on empirical data. A mathematical model of such engines is based on the "filling-and-emptying" technique. Empirical feedback is used for improving the model. Evaluation equations are provided for the cylinder closed period, cylinder open period, inlet manifold and compressor, and engine, turbocharger, and governor dynamics. There is good correspondence between calculated and experimental results. The mathematical model is used to evaluate the linearized transfer function of the diesel engine for later use in control studies.

by D. E. Winterbone; C. Thiruarooran; P. E. Wellstead  
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Rept. No. SAE-770124; 1977; 15p 12refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 970

# **DRIVER'S INABILITY TO JUDGE IMPORTANT PARAMETERS OF LEADING VEHICLE MOVEMENT AT NIGHT**

Empirical findings on the first stage of driver information processing, the transformation of physical inputs into perceptual correlates, show that there are two types of change in the leading vehicle's configuration which cue the following driver: a change in the horizontal angle between a pair of vehicle lights, i.e. taillights, and a change in angular size or apparent brightness of each light. The first change is considered more useful and is the subject of this study. The general conclusion emerging from the data is that drivers suffer from a perceptual inability to judge the magnitude of relative movement of the leading car from the behavior of its taillights. This inability may easily result in rear-end collisions in many night driving situations. Drivers of following vehicles may often be led by their estimations to close up too rapidly on the leading vehicle. Countermeasures to reduce the relatively high accident risk of night driving obviously have to start from a consideration of this type of weakness in human perceptual ability.

by Wiel H. Janssen  
Institute for Perception TNO, The Netherlands  
Rept. No. SAE-770129; 1977; 12p 7refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 971

# **PERFORMANCE OF DRIVER-VEHICLE SYSTEM IN EMERGENCY AVOIDANCE**

By means of the Emergency Avoidance Test, a new method for simulating automotive accidents on ordinary roads, it was found that while both experienced and inexperienced drivers have the same initial steer input to avoid an unexpected obstacle, experienced drivers display more stable performance in the subsequent control of the vehicle. The test consists of a course, run at 60 mph, on which polystyrene obstacles were introduced to the vehicle's path at unexpected intervals. This type of test is considered more difficult than a sudden lane-change test. Participating drivers were equipped with eye-movement recorders. Utilizing drivers' transfer functions, parameters for both experienced and inexperienced drivers were obtained from a mathematical simulation of test results. The data indicate that when vehicle yaw response is greatly delayed, inexperienced drivers may lose control, while experienced drivers will secure control of the vehicle.

by Teruo Maeda; Namio Irie; Kunihiko Hidaka; Hiroaki Nishimura  
Nissan Motor Co., Ltd., Japan  
Rept. No. SAE-770130; 1977; 27p 1ref  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 972

# **FATIGUE AND STRESS DUE TO PROLONGED DRIVING AND CHANGING TASK DEMANDS**

Two experiments are reported: on performance decrement during prolonged night driving and on driver stress during driv-

may 31, 1978

ing in different environments. Subjects in one test carried out a continuous driving task during the night, preceded and followed by a short drive, while control subjects carried out only the pre-tests and post-tests, sleeping in between. The results showed considerable decrement in driving performance (i.e. increase in lane drifting) and performance on two subsidiary tasks, due to fatigue. Heart rate, although decreasing during the drive, could not be directly related to fatigue, but was also influenced by adaptational effects. Subjects of the second experiment drove three different short test routes during daytime: in town, on a four-lane motorway, and on a two-lane rural road. Measurements were taken of driving quality (i.e. lane positioning and steering wheel angle), heart rate, and reaction time on an auditory subsidiary task. Beside being sensitive enough to differentiate between different levels of environmental complexity, heart rate variability measurements seemed very promising in facilitating the interpretation of driver behavior measurement. There also existed some remarkable differences in lateral and longitudinal control between the tests on the motorway and the rural road.

by Johan B. J. Riemersma; Paul W. Biesta; Cees Wildervanck  
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Rept. No. SAE-770134; 1977; 19p 23refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 973

## DRIVER DEMOGRAPHICS--EXERCISING THE PERSONNEL SUBSYSTEM

Human factors knowledge and methodology applied to transportation and highway safety is presented in the context of a General Personnel Subsystem (PSS) paradigm. Use of demographic techniques for issues of transportation and highway safety requires that the controlling element of each vehicle, the human element, be viewed in a systematic manner according to some defined logic. The Federal government now recognizes the need to consider the full significance of the "human factor" as it relates to comprehensive systems design analysis. The primary goal of PSS activities is to improve the safety and efficiency of man/machine environment systems through effective integration of the human operator, his tools, and his working environment. Achievement of this PSS goal is acquired through the application of engineering/industrial psychology, physiology/anatomy, and system science. Among the various types of analyses used to determine system effectiveness are standard statistical and demographic methods, failure mode and effect, fault tree, THERP (a technique for human error prediction), and cost/effectiveness techniques.

by William T. Roe  
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Rept. No. SAE-770135; 1977; 7p 4refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 974

## A TREATISE ON EXHAUST EMISSION TEST VARIABILITY

The major sources of variability of an exhaust emission test on the 1975 Federal Test Procedure (FTP) are discussed. Vehi-

cle, driver and the ambient conditions affect hydrocarbon (HC) and carbon monoxide (CO) variability significantly. On the other hand, oxides of nitrogen (NOx) and carbon dioxide (CO<sub>2</sub>) are influenced more by the differences in vehicle loading. However, the importance of any other source of variability cannot be ignored, especially when a comparison is made between two tests. Various diagnostic aids such as the "Total Torque Tester," a "Driver Evaluator," an "Exhaust Bag Cross-Check," and a "Repeatable Car," which are used for the purpose of a better correlation between measurement systems on different test sites, are described. Designed experiments were conducted on vehicles whose emission levels were at or near the standards of 0.41 grams per mile HC, 3.4 grams per mile CO, and 2.0 grams per mile NOx. A computer simulation of emissions was also employed to determine relative contributions from different sources to overall variability. Variability due to measurement error and within-vehicle variability observed in this work is plus or minus 19% of the mean for HC, plus or minus 33% of the mean for CO, plus or minus 9% of the mean for NOx and plus or minus 5% of the mean for CO<sub>2</sub>. Variability is defined as 1.96 times the coefficient of variation. The magnitude of variability depends on differences in the overall system which includes the vehicle, the measurement system and test operating conditions.

by Wiplove K. Juneja; David D. Horchler; Harold M. Haskew  
General Motors Corp., Vehicle Emission Labs.  
Rept. No. SAE-770136; 1977; 26p 13refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 975

## COMPARISON AND OPTIMIZATION OF EXHAUST EMISSION TEST PROCEDURES

Exhaust emission regulations of various countries can be categorized as certification of prototype vehicles, assembly line test of new vehicles, and in-use-compliance and inspection/maintenance programs. Distribution functions of repetitive exhaust measurement results on the same vehicles and of single measurement results on many vehicles from the assembly line are investigated. The correlation between mass emission components is also analyzed. The probabilities for passing or failing certification tests are calculated using a Monte Carlo method under consideration of the standard deviations of test data. From the results of these statistical and experimental investigations, proposals for the improvement of certification and assembly line test procedures for the USA and Europe are deduced. It is proposed that assembly line and in-use-compliance test procedures be based on averaging, thus fulfilling the requirement of air quality and avoiding distribution functions difficulties. A continuous sampling plan is recommended, similar to MIL STD 414, following the principles of a recent proposal by the California Air Resources Board.

by H. Klingenberg; M. Kuhler; K. H. Lies; L. Pazsitka; D. Schürmann  
Volkswagenwerk AG, Res. and Devel., Germany  
Rept. No. SAE-770137; 1977; 12p 23refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. Supported by German Dept. of the Interior under No. VEP-312-125/III-A-215.  
Availability: SAE

HS-021 976

### A QUALITY CONTROL TECHNIQUE FOR CORRELATING EXHAUST GAS ANALYSIS SYSTEMS

A simple inexpensive, critical flow blender has been developed for filling a tedlar bag with controllable concentrations of hydrocarbon, oxides of nitrogen, carbon dioxide, and carbon monoxide gases at levels encountered in automobile emissions testing. According to a daily schedule, a technician takes the bag to all analyzer sites in the laboratory for analysis. The concentrations indicated by each site are compared to the overall averages. The results are stored in a computerized data base from which control charts, statistical analyses, and interpretations of significant differences among test sites can be made. The advantages of this quality control technique include inexpensive apparatus and minimum personnel; simple, easy, and quick performance; ability to quantify control and correlation; availability of diagnostic information on analyzer performance; monitoring of historical trends and changes; ability to qualify new analyzers; and provision of long term assessment of improvements or deterioration of control. Analyzer site differences can be reduced to less than 1% and day-to-day variability can be maintained below plus or minus 2%.

by C. Don Paulsell; John Keller  
Environmental Protection Agency  
Rept. No. SAE-770138; 1977; 19p 1ref  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 977

### TORQUE MEASUREMENTS AND MECHANIZED DRIVER FOR CORRELATING EXHAUST EMISSION TEST FACILITIES

The main sources of error in exhaust emissions measurement are the driver and the dynamometer. A mechanized driver has been developed to achieve a good reproducibility in dynamometer calibration. The torque measured on the drive shaft of a test car by two complementary methods is used as a criterion for this calibration. The static method yields the complete dynamometer characteristic: torque versus car speed; the dynamic method uses the averaged time integral of the torque measured over a driving cycle. The described torque method represents an improvement over the "coast down" technique, in that the drive roll bearings are loaded with the vehicle weight as under regular test conditions and possible bearing defects can be detected.

by H. Klingenberg; D. Kinne; D. Schurmann  
Volkswagenwerk AG, Res. and Devel., Wolfsburg, Germany  
Rept. No. SAE-770139; 1977; 12p 12refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977. Supported by  
German Dept. of the Interior under No. VEP-312-125/III-A-215.  
Availability: SAE

HS-021 978

### NEW LASER PARTICLE SIZING INSTRUMENT

A new laser particle-sizing instrument constructed for on-line particle sizing of combustion exhausts measures the optical ex-

inction associated with single particles as they flow through focused laser beams. Two focused beams which cross at the minimum diameter along with coincident-pulse detection electronics are used to size only those particles which traverse simultaneously both focused beams. Donut mode intensit beams together with double-pulse detection circuitry are used to ensure the particles which are measured have traversed the peak laser intensity. Opaque particles in the size range 0.0 micron to 5.0 microns in diameter can be sized with a diameter resolution of better than 10%. The present instrument can size approximately 1000 particles in three minutes at its maximum allowable particle concentration of 10 to the 5th power particles/cu cm. Both particle size distribution and particle emission rate from a diesel automobile exhaust which were measured over an FTP (Federal Test Procedure) cycle using a prototype instrument are given.

by Frederick R. Faxvog  
General Motors Res. Lab., Physics Dept.  
Rept. No. SAE-770140; 1977; 8p 10refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 979

### ANALYZERS FOR METHANE IN EXHAUST GAS

A gas chromatographic instrument can measure methane in diluted automotive exhaust on a 60-second cycle with a standard deviation of 0.06 ppm methane and with no known interferences. The method has been approved by the Society of Automotive Engineers (SAE) and has been published as SAE J1151. (A copy of this Recommended Practice is appended.) In addition, a prototype selective combustor for continuous methane determination in exhaust has been evaluated and found to be satisfactory. Agreement with the inherently more accurate gas chromatograph is within about 10%. Further development may improve the performance significantly. It should be kept in mind that NMHC (nonmethane hydrocarbon), not methane, measurements are of primary concern. A 10% error in methane concentration, which might be 30% of the total hydrocarbons in automotive emissions, results in only about a 4% error in the NMHC value.

by Arnold Probst; Glenn D. Reschke  
General Motors Corp., Milford Vehicle Emission Lab.  
Rept. No. SAE-770143; 1977; 10p 3refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 980

### AUTOMOTIVE HYDROCARBON EMISSION PATTERNS IN THE MEASUREMENT OF NONMETHANE HYDROCARBON EMISSION RATES

Emission rates of 56 hydrocarbons (HC) from 22 motor vehicles, including catalyst and noncatalyst configurations, were determined for the Federal Urban Driving Cycle and analytical procedures for determining vehicle nonmethane hydrocarbon (NMHC) emission rates evaluated. The vehicle tests indicated that control systems based on catalysts reduce NMHC emissions to a much greater extent than they reduce methane emissions. Methane accounted for an average of about 17.3% of the total hydrocarbons (THC) emitted from the catalyst-

emission-control group. The relative abundance of olefinic HC in lean-combustion exhaust is greater than with catalyst vehicles, about 33.9% and 17.6%, respectively. With respect to the procedures for determining NMHC emission rates, in general they require independent THC and methane analysis, with the NMHC level calculated by difference. The procedures were evaluated by comparison of indicated NMHC emission rates with rates obtained by summation of individual compound rates determined by advanced gas chromatographic procedures. Simple accurate analytical procedures exist for determination of motor vehicle NMHC emission rates; the most accurate procedure depends on the detailed character of the emissions being analyzed. The most universally applicable THC procedure would use a FID (flame ionization detection) fueled with 40/60 H<sub>2</sub>/He (hydrogen/helium). However, for advanced catalyst vehicles, the most accurate procedure would use a FID fueled with 55/45 H<sub>2</sub>/He. Both infrared optical procedures and simplified peak height gas chromatographic procedures are satisfactory for methane analysis. The recommended procedure for determination of vehicle NMHC emission rate would include analysis of test phase NMHC concentration (the difference between THC and methane levels) and subsequent calculation as prescribed in the Federal Register. The HC density value used in the calculation of NMHC/g/mi emission rate should remain unchanged at 16.33 g/cu ft for a test fuel H/C (hydrogen/carbon) ratio of 1.85 as with Indolene.

by Frank Black; Larry High  
Environmental Protection Agency  
Rept. No. SAE-770144; 1977; 19p 9refs  
Presented at International Engineering Congress and  
Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 981

## THE USE OF GAS ENGINES FOR MOTOR VEHICLES IN OIL EXPORTING COUNTRIES

Although even limited adaption of natural gas (NG) as an automotive fuel in oil-exporting countries to gasoline and diesel fuels would entail extensive development work and high initial capital, it would be unwise to ignore the potential of NG since it has benefits in reducing noise and pollution and also because of the implications of energy economics. Oil-producing countries should actively consider using the gas released during drilling for internal use for vehicular fuel, leaving their oil for export and for industrial use. Also, these countries should develop their industries to allow them to use NG as a starting material. NG would be limited in vehicular applications to use by fleet vehicles, where it offers performance and environmental advantages, without the difficulties in distribution which hamper its more widespread use. The conversion of gasoline engines of fleet vehicles to NG can further be justified on economic grounds; however, the conversion of diesel engines cannot be justified on economic grounds alone.

by M. Rashidi; M. S. Massoudi  
Arya-Mehr Univ. of Technology, Dept. of Mechanical  
Engineering  
Rept. No. SAE-770145; 1977; 10p 11refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

Annual surveys for octane number (ON) requirements of Japanese model passenger cars during 1959-1975 were conducted by a Subcommittee of the Octane Number Requirement Survey, Gasoline Div., Product Section of the Japan Petroleum Inst. in cooperation with various oil companies and the National Research Inst. for Pollution and Resources of the Mining of International Trade and Industry. ON requirements at 50% car satisfaction level with PR (primary reference) fuels showed a steadily increasing tendency from 1960 to 1972. Trends of ON requirements at 90% satisfaction level were nearly the same. However, since 1973 these requirements decreased, thus reversing a 13-year trend. In 1975 ON requirements were 89.4 ON at 50% car satisfaction level and 93.5 ON at the 90% level. According to test results obtained in 1971 and 1972, road ON depreciations were not considerably different between unleaded and leaded reference fuel series. Using TEL (tetraethyl lead), road ON depreciations for reformed-type reference fuel were more than those for mixed-type reference fuels, but the depreciations using TML (tetramethyl lead) were nearly equal to each other. The percentage of cars having maximum ON requirements at low engine speed, about 1000 rpm, gradually decreased each year during the 13-year period. Over 90% of the cars tested showed maximum ON requirements at full-throttle acceleration. An almost linear relationship between compression ratio and ON requirements was found, but 95% confidence limits of this relationship were more than plus or minus 7 ON, which suggested that ON requirement was considerably affected by other factors than compression ratio. The following test conditions were altered from the standard test method: acceleration at minimum obtainable speed or 1500 rpm; no adjustment in basic spark timing for cars as received; and evaluation of knock intensity at light knock level. ON requirement for automatic transmission cars was nearly equal or less, by 2-4 ON, than those for manual-transmission cars equipped with the same engine models. ON requirements for trucks carrying maximum load were equal to or slightly higher than those for passenger cars equipped with the same model engine. Finally, the percentage of cars whose high-speed ON requirements were less than those obtained by the standard method were 75%-80% with FBR (full boiling range) fuels; and the ON requirement distribution of 1975 model passenger cars at 50% and 90% car satisfaction levels for high-speed range were 85.9 and 90.2 ON, respectively.

by Kiyoshi Nakajima  
Nippon Oil Co., Ltd.  
Rept. No. SAE-770146; 1977; 14p 5refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977. Study sponsored  
by Petroleum Assoc. of Japan. Paper based on rept. by Japan  
Petroleum Inst.  
Availability: SAE

HS-021 983

## ENGINE FAILURE AND HIGH SPEED KNOCK

The relationship between engine failure and knock intensity was studied by testing a European engine at 4000 and 5000 rpm, on full throttle. With a sounder knowledge of the causes of knock, combustion chamber design will be examined so as to allow higher compression ratios and consequent lower fuel

consumption, consistent with the antiknock properties of gasoline. Engine failure depends on knock level deriving from a negative octane balance. The absolute value of minimum octane balance which will cause engine failure from 4000 to 5000 rpm, wide-open throttle, decreases 3.0 to 1.5; i.e. a gasoline rated at 1.5 ON (octane number) below engine octane requirement results in knock-induced failure at 5000 rpm. Mechanical strength will be adversely affected by temperature increases occurring both during preheat and in knock conditions. Knock-induced failure might well be the result of a weak-spinning detonation wave generated at the end of flame front progression. Knock can be retarded by reducing the flame travel time and optimizing turbulence. A new combustion chamber development resulted in a .5 compression ratio increase for the same octane requirement. A further reduction in fuel consumption could be obtained by improving gasoline motor ON characteristics.

by G. M. Cornetti; F. De Cristofaro; R. Gozzelino  
FIAT Res. Center, Italy  
Rept. No. SAE-770147; 1977; 14p 22refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 984

#### THE EFFECTIVENESS OF BELT SYSTEMS IN FRONTAL AND ROLLOVER CRASHES

The effectiveness of belt systems in frontal and rollover automobile crashes was evaluated by analyzing data on front-seat outboard occupants (drivers and far-right front passengers) who were involved in these types of accidents and who were either lap belted, lap-shoulder belted, or unrestrained. Data were obtained on 8000 vehicles in the Collision Performance and Injury Report (CPIR) file of the Hwy. Safety Res. Inst. There were 14,000 occupants, of whom 5103 were front-seat outboard passengers 16 years of age or older involved in frontal collisions, and 994 were involved in rollovers. In the frontal crash, the lap-shoulder belt is shown to reduce the occurrence of the severe, serious, critical-to-life injuries, and fatalities resulting from injuries sustained in any region of the body (head, neck, thorax, lower torso, and extremities). In addition, there is a strong association between belt usage and the occupant escaping from the crash with no injury. In rollover crashes, belts reduce the frequency of the more severe injuries by preventing the occupant from being ejected. For those occupants not ejected from the car, belts effectively reduce the fatalities and the more serious injuries.

by Donald F. Huelke; Thomas E. Lawson; Robert Scott;  
Joseph C. Marsh, 4th  
University of Michigan  
Rept. No. SAE-770148; 1977; 12p 33refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 985

#### SEVERE TO FATAL INJURIES TO LAP-SHOULDER BELTED CAR OCCUPANTS

Details are presented of 35 crashes wherein 39 lap-shoulder-belted, front-seat car occupants sustained severe-to-fatal injuries: 15 involved in frontal collisions and 24 in side-impact collisions. Case descriptions of these crashes are presented, each

including vehicle, environmental, and injury details. In the frontal collisions there were nine chest injuries of Abbreviated Injury Scale (AIS) 3 or greater due to impact with steering assemblies, shoulder belts, and instrument panels. Two of the more severe head injuries involved support pillars or the roof side rail. Of the nine severe injuries in the side impacts, most involved head, chest, and/or abdomen. There were ten fatalities. Few of the injuries of significance in both frontal and rollover crashes were due directly to the belt systems. In three individuals, chest-related belt injuries were recorded and two other front-seat occupants had abdominal/lap-belt injuries. Indirect back or neck injuries were infrequent but were related directly to serious injuries of the spine. These belt-induced injuries were not greater than one would expect to find in unbelted occupants in the same crashes. Belt systems reduce the more severe injuries in frontal and rollover crashes. Other potential restraint systems do not appear to offer any greater occupant protection in case of side impact.

by D. F. Huelke; H. W. Sherman; M. J. Murphy  
University of Michigan  
Rept. No. SAE-770149; 1977; 20p 18refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 996

#### ALCOHOL-DRIVING COUNTERMEASURES TREATMENT/EDUCATION DIRECTORY

Colorado's hospitals, centers, missions, and other agencies which deal with alcoholism and other aspects of mental health are listed alphabetically, with information on the following: address, phone, personal contact, fee, and services available. The agencies are also indexed by region of the state. About 115 agencies are listed.

Colorado Div. of Hwy. Safety, Alcohol-Driving  
Countermeasures, 4201 E. Arkansas Ave., Denver, Colo.  
80222  
1976; 52p  
Availability: Corporate author

HS-021 997

#### ALCOHOL EDUCATION PROGRAM DEVELOPMENT GUIDE

An alcohol education program is outlined which is designed for use by those who have been convicted of drunk driving. The following material is covered in seven sessions in addition to an initial intake session: physiological, psychological, and social aspects of alcoholism; effects of alcohol on perception, decisionmaking, and performance; legal issues; progressive stages of alcoholism; alternatives to problem drinking; and referral resources. Interesting and articulate resource people, small classes with group participation, and continuity between sessions are vital to success. Instructors should be well trained, genuine, empathetic, and warm without being possessive. Such programs can be of value for the problem drinker in the early stages or for the more serious problem drinker either prior to or together with intensive therapy.

Colorado Div. of Hwy. Safety, Alcohol-Driving  
Countermeasures, 4201 E. Arkansas Ave., Denver, Colo.  
80222  
1976; 30p 6refs  
Availability: Corporate author

HS-021 998

# **EVALUATION MANUAL. ALCOHOL-DRIVING COUNTERMEASURES**

Guidelines are presented for evaluating persons convicted of drunk driving to determine the extent of their drinking problems. Such evaluation is usually part of a presentence investigation and includes a diagnostic interview and administration of the drinking history questionnaire (DHQ). Classification of drinker types are problem drinker, incipient problem drinker, and social drinker. Criteria for classifying an individual as a problem drinker are listed and are keyed to the indicative questions on the DHQ. The interviewer should not underdiagnose. The most common indicators of problem drinking include the following: high blood alcohol level (BAL) at time of arrest; prior arrest record; blackouts; passing out; self-admission of problem drinking; poor marital, family, social, and work relationships; psychological dependence; and personality changes. Denial on the part of the problem drinker should not be taken as intentional lying. When evaluating the evidence, the evaluator should not be influenced either by the length of time between drinking problems or by the immediate outlook. BAL does not tell how drunk a person is, but only how much he has had to drink. The presumptive limit of .10% is very generous, as it is the equivalent of five drinks in one hour for a person of average size. Each drink adds about .02% to the BAL; one hour is required for the body to eliminate its effects. Criteria by which to make referrals to treatment include accessibility or proximity, need for a particular type of treatment, cost, and obligation to the court. Educational programs are most suitable for incipient or borderline problem drinkers and for those with more serious problems who deny their drinking problems. Most referral agencies have specific catchment areas within the community. Antabuse treatment should be recommended to those who had a very high BAL, and to those who have been in various types of treatment before. A copy of the DHQ is appended to the manual.

Colorado Div. of Hwy. Safety, Alcohol-Driving Countermeasures, 4201 E. Arkansas Ave., Denver, Colo. 80222

1976?; 42p

Availability: Corporate author

HS-021 999

# **MONITORING THE EFFECTIVENESS OF STATE TRANSPORTATION SERVICES. FINAL REPORT**

Procedures that state governments might use to monitor the effectiveness of state transportation services on a regular (preferably annual) basis were developed with assistance from transportation, planning, and budget staffs in the states of North Carolina and Wisconsin. Measurement procedures are discussed for assessing the outcomes of a variety of state transportation services, including highway planning, maintenance, mass transit, the division of motor vehicles, and highway emergency services. Measures of effectiveness and data collection procedures addressing the following state transportation concerns are described: rapid movement; access to important destinations; safety; travel convenience and comfort (including road rideability); environmental and aesthetic impacts; and provision of quality services to citizens in terms of courtesy, fairness, responsiveness, and equitability. A special section on measuring the effectiveness of local and intercity mass transit services is included. Many of the suggested measures utilize data obtained from ratings by trained observers or

statewide surveys of citizens. An illustrative citizen survey for obtaining information on a variety of state transportation effectiveness concerns is provided as an appendix; it is based on the results of statewide citizen surveys tested in North Carolina and Wisconsin. Experiences regarding tests of a number of other measures by these and other states, including cost information, are also reported.

by John M. Greiner; John R. Hall, Jr.; Harry P. Hatry; Philip S. Schaeffer  
Urban Inst., 2100 M St., N.W., Washington, D.C. 20037  
Grant NP5AC019  
Rept. No. DOT-TPI-10-77-23; 5039-01; 1977; 168p 117refs  
Rept. for Mar 1975-Jul 1977. Sponsored by DOT Office of Transportation Systems Analysis and Information, and prepared under a grant from the National Center for Productivity and Quality of Working Life.  
Availability: Dept. of Transportation, Office of the Assistant Secretary for Policy, Plans and International Affairs, Washington, D.C. 20590

HS-022 000

# **FUTURE REQUIREMENTS FOR HEAT RESISTANT ELASTOMERS FOR UNDERHOOD AUTOMOTIVE APPLICATIONS**

Experimental laboratory data on conventional and heat-resistant elastomers and performance test data on cars equipped with mandated emission controls are presented to show temperature trends in future automobiles. Mandated emission controls have resulted in numerous modifications and additions to the engine to meet ever-increasing emission requirements; these changes have caused significant increases in underhood temperatures. Data on conventional elastomers (nitrile, polychloroprene X, polychloroprene Y) show excessive hardening and loss of physical properties after relative short-term exposure at elevated temperature. More recent elastomers (chlorinated polyethylene, epichlorohydrin copolymer, chlorosulfonated polyethylene) show much improved performance over the conventional elastomers. Emission controls effective for 1980 model cars will significantly increase underhood temperatures over and above temperatures now experienced as automotive manufacturers modify the internal combustion engine and add new catalytic converters to comply with these requirements. Conventional elastomers cannot withstand the increased temperatures projected for the future vehicles.

by Mack Carter, Jr.  
Chrysler Corp.  
Rept. No. SAE-770858; 1977; 8p 2refs  
Presented at Passenger Car Meeting, Detroit, 26-30 Sep 1977.  
Availability: SAE

HS-022 001

# **MAXIMIZATION OF HIGHWAY FREIGHT MOVEMENT USING A NEW TRACTOR TRAILER CONCEPT**

An outline of considerations, design approach, and preliminary performance results are presented for a new highway freight-transporting vehicle which maximizes the available payload space within existing regulatory limitations. This new vehicle offers operational increases in payload volume of 16%-38% when compared to current road combinations. The present accepted layout of highway freight transporting vehicles



generally places the powerplant/transmission at the extreme front of the vehicle over the front steering axle, the driver compartment over or directly behind the powerplant, the rear driving axle(s) directly behind the powerplant/transmission and the freight box or trailer(s) behind the driver compartment. The new system places the entire tractor unit in a forward but lowered position which allows the available cargo space to be extended to the extreme frontal plane of the overall length limitation peculiar to the area of operation. The driver is located ahead of the forward steering axle(s) but conventionally ahead of the rear driving axle(s). This layout is totally compatible with accepted and standardly available running gear, powerplant, transmission, drive-line brake, axle, steering, tire and wheel components, but requires new approaches to control design, chassis-frame member layout, and driver compartment design. Primary consideration in all design decisions was given to driver safety and comfort.

by R. L. Zubko  
Strick Corp.  
Rept. No. SAE-770890; 1977; 8p  
Presented at Truck Meeting, Cleveland, 3-6 Oct 1977.  
Availability: SAE

HS-022 002

### AN ADVANCED DRIVER EDUCATION PROGRAM

An Advanced Driver Education Program is designed around the concept of training drivers to handle specific driving emergencies that accident-causation data indicate are driver problems. The measure of program performance is not a measure of increased skill, but must be related to accident-reduction potential. The program has a maximized benefit/cost ratio. The method of determining the driving emergencies occurring frequently (skids, improper evasive maneuvers, improper off-road recovery, improper braking) are discussed in detail as are the six individual training exercises (off-road recovery, skids, evasive maneuvers, controlled braking, tire blowouts, serpentine course). The entire program is designed to be conducted in a single eight-hour period with two hours devoted to two classroom sessions and the remaining six hours on the driving exercises. Each exercise accommodates three students per car so that the actual behind-the-wheel time is two hours per person and the remainder, observation time. Evaluation of this program by means of comparing trained and untrained control groups indicates a large reduction in both numbers of accidents and accident severity.

by R. A. Whitworth  
General Motors Proving Ground, Traffic Safety Dept.  
Rept. No. SAE-770798; 1977; 12p 20refs  
Presented at Passenger Car Meeting, Detroit, 26-30 Sep 1977.  
Availability: SAE

HS-022 003

### COMPARISON OF SIX HIGHWAY AIR POLLUTION DISPERSION MODELS USING SYNTHETIC DATA. FINAL REPORT

The second of two studies of the performance of highway air pollution dispersion models using synthetic data (either measured or artificially constructed input data for models, consisting of traffic and meteorological parameters) tested six models with a new synthetic data base. Five of the models were of the Gaussian type (those developed by California Div. of

Highways (CAL), Environmental Systems Lab. (ESL), Res. Corp. of New England (TRC), Transportation Systems Center, and the Environmental Protection Agency (TSC/EPA), and Walden Research Associates (WAL)); the sixth model was exponential (General Electric (GE)). The air pollution predictions of the six models were compared in pairs, and various measures of the difference between the predictions of each pair were calculated. A group of three models (CAL, TSC/EPA, WAL) generating very similar predictions was discovered; these are called Consensus Models. In the first study, using the same analytical approach, these three models were also found to be Consensus Models, along with others which could not be tested in the present study. Synthetic data testing can only reveal the degree of agreement among predictions. The capability of these models to predict real-world air pollution cannot be determined until an air-quality data base suitable for model validation becomes available.

by Paul J. Downey; Jeffrey D. Garlitz; Kevin H. Murphy  
Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142  
Rept. No. DOT-TSC-OST-76-58; 1977; 193p 8refs  
Rept. for Nov 1975-Mar 1976. See also DOT-TSC-OST-77-33, Jun 1977.  
Availability: NTIS

HS-022 004

### SLIPS AND FALLS-TRUCK RELATED PERSONAL INJURY ACCIDENTS

A survey of vehicle-related slip or fall-type injuries in the trucking industry during 1974 entailed visits to 46 carriers throughout the U.S. and the search of 21,644 records. The survey is broken down into the following four categories: tank vehicles, auto transporters, flatbed equipment, and vans. Slips and falls accounted for 14% of all driver personal injury accidents and 9% of all carriers' personal injury accidents. Slip and fall medical costs accounted for 11% of carriers' total medical costs. Slip and fall workmen's compensation costs accounted for 10% of carriers' total workmen's compensation costs. Approximately 54% of slip and fall incidents happened on the tractor or the driver area and 46% happened on the trailer or cargo area. Tank carriers had the highest percentage of driver slips and falls (23%), followed by auto transporters (14%), van-type (11%), and flatbed (9%). With the exception of auto transporters, which had a higher incidence rate, the other three types of carriers had about the same rate for slips and falls per million vehicle miles, slips and falls per dispatch, and slips and falls per drivers employed. Auto transporters had a higher incidence rate of slips and falls per million driver man-hours and higher medical and lost-time costs than the other three. As could be expected the majority of injuries for the auto transporters occurred in the cargo area. In addition to the national survey, a survey of the State of California's injury experience for the first three months of 1974 was conducted and results are appended; slips and falls accounted for about 25% of the disabling work injuries in that study.

Bureau of Motor Carrier Safety, 400 7th St., S.W., Washington, D.C. 20590  
1977; 44p  
Availability: Corporate author

HS-022 011

## STATE OF COLORADO ANNUAL TRAFFIC SAFETY WORK PROGRAM. FISCAL YEAR 1978

Potential activities to be implemented under Colorado's Traffic Safety Program for the fiscal year beginning Oct 1977 and ending 30 Sep 1978 are identified. All of the objectives identified herein are supported with funds made available under the Hwy. Safety Act of 1966, as amended, and state and local funds. The first of three sections of the Annual Work Prog. (AWP) consists of a summary of costs for those programs submitted and adopted as essential to complete development of the state goals for traffic safety. These costs are shown in terms of agency programs and subelement programs and also by standard area. Federal funds expended and obligated for FY 1968 through FY 1977 are also tabulated. The second section, program analysis, contains the data used by the Div. of Hwy. Safety of the Colorado Dept. of Highways to identify potential areas in which Federal funds could be used effectively. The third section, program description, provides information on the subelements of the Colorado Traffic Safety Prog. and its subprograms. Each subelement contains a problem statement, program purpose, related objectives and tasks with quarterly milestones, and a detailed narrative of planned programs and subprograms. The programs deal with the following: administration; drunk-driving countermeasures; traffic records; codes and laws; police traffic services; traffic court; emergency medical services; traffic safety instruction; driver licensing; and pedestrian safety. Other programs deal with motor vehicle requirements, and with identification and surveillance of accident locations; roadway design, construction, and maintenance; and traffic engineering services.

Colorado Dept. of Highways, Div. of Hwy. Safety, 4201 E. Arkansas Ave., Denver, Colo. 80222  
1977; 142p

Prepared in cooperation with the National Hwy. Traffic Safety Administration and the Federal Hwy. Administration.  
Availability: Corporate author

HS-022 012

## COLORADO SCHOOL BUS DRIVER INSTRUCTIONAL MANUAL

An instructional manual for use by drivers of school buses in the State of Colorado outlines the driver's responsibility to the passengers, the parents, fellow employees, the driver himself/herself, and the vehicle, as well as outlines the driver's role in public relations and team work. In addition, a section on vehicle maintenance deals with vehicle components, vehicle maintenance programs (operations and driver responsibility), and safety inspections. Colorado rules and regulations, standard operating procedures, special operating conditions, and defensive driving are also considered.

Colorado Dept. of Education, Office of Field Services, Denver, Colo.

1975; 70p

Published under a grant from Colorado Div. of Hwy. Safety.  
Availability: Corporate author

HS-022 013

## A MANAGEMENT SYSTEM FOR EVALUATING THE VIRGINIA PERIODIC MOTOR VEHICLE INSPECTION PROGRAM

A management system for evaluating Virginia's periodic motor vehicle inspection program was developed based on a sample size of approximately 36,000 inspection receipts and a sampling procedure based on stratifying the sample according to inspection station classification (private, small exemption, and unlimited) and station volume (low, medium, and high). Since the use of this procedure will permit the Virginia Dept. of State Police to sample fewer receipts than sampled in previous evaluations and should also allow for more suitable statewide inferences concerning Virginia's periodic motor vehicle inspection program, it is recommended that the State Police adopt this evaluation procedure. A total of 35,016 approval receipts was sampled and analyzed from the 6,325,485 inspection receipts issued during 1975; it was found that 22.62% of the vehicles inspected and approved immediately or after repair at the time of inspection were defective in some way. The percentages of defective vehicles were similar for passenger vehicles, trucks, and school buses. Private inspection stations had a somewhat higher percentage of defective vehicles than unlimited or small exception stations. Headlights, other lights, brakes, and tires were among the items most often reported as defective. For most inspection items there was a slightly greater failure rate for low-volume stations than for medium-volume or high-volume stations. There was generally an increase in defects as vehicle age and mileage increased. The following limitations in the design of the current inspection receipt were noted: no indication of the specific component which is defective and the severity of the defect, no space for notation of the charges for repairs for individual items, and no assurance of an accurate recording of vehicle mileage.

by Deborah Mitchell  
Virginia Hwy. and Transportation Res. Council,  
Charlottesville, Va.  
Rept. No. VHTRC-78-R19; 1977; 44p 9refs  
Sponsored by the Hwy. Safety Div. of Virginia.  
Availability: Corporate author

HS-022 014

## INVESTIGATION OF THE RAM AIR EFFECTS ON THE AIR SIDE COOLING SYSTEM PERFORMANCE OF A NORTH AMERICAN CAR

Datum road tests and preliminary wind-tunnel testing were conducted on a 1976 Ford Granada as the test vehicle in the 3m x 6m Propulsion Wind Tunnel of the Div. of Mechanical Engineering, National Res. Council of Canada. The wind tunnel section was of the closed type and was provided with an elevated ground plane on which the test vehicle was placed. It was found that the centerline air speed averaged over the distance equal to hood height minus ground clearance is 88% of the true vehicle speed one meter upstream of the test vehicle. The air speeds below the front bumper were lower than at one meter ahead of the test vehicle. The static pressures underneath the engine bay were very close to pressures inside the engine bay and slightly positive relative to ambient. Coolant system resistance had to be held constant in order to achieve stable radiator temperatures. Cooling air flows, fan thrust, and torque appear to show dependence on temperature and ram air speed. The temperature dependence apparently cannot be accounted for by density changes alone. The com-

bination of the test vehicle and the ground board structure did not produce unsteadiness in the wind tunnel flow. The blockage effects due to the vehicle and ground board structure in the wind tunnel are significant and dependent on vehicle position on the ground board relative to the ground board's leading edge. The air speeds underneath the vehicle without its catchment pan tended to exceed those observed during road tests. The engine bay pressure was correspondingly low, but still positive. The cooling air catchment duct caused a local blockage effect that reduced the maximum velocity overshoot underneath the front bumper observed for the clean vehicle configuration. Use of slot suction just upstream of the catchment pan facilitated adjusting this velocity maximum to match road test data. Representative distributions of cooling air flow behind the radiator can be produced in the wind tunnel provided that the correct engine bay pressure and velocity maximum in the profile below the front bumper are generated.

by U. W. Schaub

National Res. Council Canada, Engine Lab., Ottawa, Ont.  
Rept. No. DME/NAE-1977(3); 1977; 26p 6refs  
Prepared in cooperation with Canadian Fram Ltd., Ontario  
Ministry of Transport and Communication, Canadian Ministry  
of Transport, and Township of Gloucester.  
Availability: Corporate author

HS-022 015

#### EFFECT OF TIRE WEAR ON SKID RESISTANCE. FINAL REPORT

The Calspan Advanced Tire Res. Facility was utilized to measure, under controlled laboratory conditions, the braking traction coefficients of ASTM E501 tires as a function of tread depth, velocity, and water-film thickness. Data were collected using shaved and used (roadworn) tires in the slip ratio range from zero to -1. Six different ASTM tires were shaved to nine different tread depths spanning the range from 0% to 100% tread depth. Four different roadworn ASTM tires were tested spanning the range from 28% to 93% tread depth. Data were taken at nominal velocities of 20, 40, and 60 mph and water depths of 0.02 and 0.04 inches. At constant speed, braking traction coefficients for shaved tires linearly decreased with decreasing tread depth, with the rate of loss of traction increasing with velocity and water-film thickness. Test results for the used tires did not correlate with those for the shaved tires. Braking traction coefficients for the former exhibited no consistent sensitivity to tread depth at constant speed. Experience gained in the execution of the test program and an analysis of the test data have prompted certain recommendations. Shaved tires should be prepared by the removal of a uniform depth of rubber around the entire circumference. Test sequences on each tire should be performed in more random manner to obtain a better measure of the random experimental scatter in the data. Roadworn tires free of any obvious flat spots should be used in future tests. A wider range of tread depths of roadworn tires should be tested. A more accurate device (than a standard tire tread-depth gauge calibrated in the 32nd's of an inch, modified to improve reading accuracy) should be employed in measuring tread depth in future tests.

by I. Gusakov; G. A. Tapia; L. Bogdan  
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract FHWA-7-3-0010  
Rept. No. FHWA-RD-77-105; ZM-6043-7-1; 1977; 44p 9refs  
Rept. for Oct 1976-Jun 1977.  
Availability: NTIS

HS-022 016

#### WEAK POINTS OF CARS. PERIODIC INSPECTIONS DURING 1977. SEPARATE ACCOUNT OF THE FAULTS IN PASSENGER CARS OF THE 1970, 1972 AND 1974 MODELS

In this annual report from the Swedish Motor Vehicle Inspection Co., statistics based on information collected during a periodic inspection of all registered vehicles in Mar 1977 as part of the compulsory annual inspection are presented as well as a separate account of the inspection results for 1970, 1972, and 1974 model year passenger cars. Data mainly take the form of relative observation frequencies of defects for different vehicle systems and subsystems for different kinds of vehicles. High observation frequencies have been considered to indicate "weak points" in vehicles as well as in particular kinds of vehicles and vehicle makes/types. The review of the 1970, 1972, and 1974 models includes 60% of all makes/types of passenger cars of those model years. The data presented for each car type include the following: principal data (e.g. car dimensions); approximate price of car; relative observation frequency of defects for seven main components (structure, wheel system, propulsion system, braking system, steering system, body, communication system); observation frequency for average car of particular model year; for each car type and for the average car, the percentage of vehicles passing inspection without observations and the percentage having one or more observations for defects in any component; most common defective main systems and their most common defective subsystems/components (percentages and types of defects given); median odometer readings for youngest year models; and mileage groups for different makes/types. The following passenger cars by make are included: Alfa Romeo Alfesud, Audi 100LS, Audi 80 L, Austin Allegro, Austin Mini, Austin Maxi, BMW 1602, BMW 2002, Citroen GS, Citroen DS, DAF 66, Datsun 100A, Datsun 120Y, Fiat 127, Fiat 128, Fiat 124, Fiat 125, Ford Escort, Ford Taunus 1600, Ford 17 M, Ford Consul, Ford Granada, Honda Civic, Mazda 616, Mazda 1300, Mazda 929, Mercedes-Benz 200, Mercedes-Benz 220 Diesel, Opel Kadett, Opel Ascona, Opel Rekord, Opel Commodore, Opel Rekord Diesel, Peugeot 104, Peugeot 204, Peugeot 304, Peugeot 504, Peugeot 504 Diesel, Renault 4, Renault 6, Renault 12, Renault 16, Renault 5, SAAB 99 Combi Coupe, SAAB 99 2.0, SAAB 99 EMS, SAAB 96, Simca 1100, Toyota Corolla, Toyota 1600, Vauxhall Viva, Volkswagen 1303 S, Volkswagen 1600, Volkswagen K 70, Volkswagen Passat L, Volvo 142 DL, Volvo 144 DL, Volvo 142 GL, and Volvo 164.

Aktiebolaget Svensk Bilprovning, Fack, S-162 10 Vällingby,  
Stockholm, Sweden  
1978; 138p  
Availability: Corporate author

HS-022 017

#### CAN DIESEL SPECIFIC POWER BE INCREASED?

After a brief discussion of the three basic ways to increase air flow, and thus the power capability, of a diesel engine (increased speed, increased displacement, increased specific output), the advantages and disadvantages of the most attractive method, increased specific output, are discussed. The discussion of the advantages centers around specific volume of the engine, specific weight of the engine, fuel consumption, heat rejection in the vehicle cooling system, hydrocarbon emissions, specific cost, manufacturing investment, and ser-

may 31, 1978

vice parts. Disadvantages of the high-output diesel engine design philosophy are discussed in terms of increased thermal loading of engine components, increased mechanical loading of engine components, and the decreased ability to provide desired low-speed torque characteristics.

Publ: Automotive Engineering v85 n12 p66-9 (Dec 1977) 1977

Based on SAE-770755 "High Output Diesel Engine Design Philosophy," by Bob Martin and Gordon Wright, presented at Off-Highway Vehicle Meeting, Milwaukee, 12-15 Sep 1977. Availability: See publication

HS-022 018

## TRUCK EXHAUST NOISE: CHALLENGE FOR THE 1980'S

Ways in which to attenuate truck exhaust noise to meet the demands of government standards and trucking industry requirements which will be effective in the 1980's are discussed. Engineers hope to get exhaust noise down to 65-68 dBA for trucks of the next decade; this compares with current systems attenuating the nominal 100 dBA, straight-pipe noise to the low 70's. The four principal components of exhaust noise (tailpipe discharge, muffler-shell noise, pipe ring, and system leaks) and means of achieving target noise levels which have been estimated for these components to meet 1982 standards (61 dBA, 59 dBA, 59 dBA, and 55 dBA, respectively) are discussed. Turbocharging will be increasingly common in truck diesels. Exhaust systems of 5-inch diameter pipe will be retained, with damped pipe in most applications. Mufflers will grow to 12-inch diameters, and these units will also feature damping for shell-noise control. These components will be integrated into essentially leakproof systems, many of which will adopt distributed attenuation. The systems will control exhaust noise to the 65-68 dBA range, with 20% less flow losses than those of current systems.

Publ: Automotive Engineering v85 n12 p58-61 (Dec 1977) 1977

Based on SAE-770893 "Exhaust System Considerations for 1982 Heavy Duty Trucks," by Douglas W. Rowley, presented at Truck Meeting, Cleveland, 3-6 Oct 1977. Availability: See publication

HS-022 019

## COMPUTER-GENERATED READOUTS RECORD DRIVER/VEHICLE INTERACTIONS

A system is described which measures and records driver input and vehicle response and whose computer-generated readouts quantify elements of the driver/vehicle interface. This system used on-board sensing and multiplexed recording, with taped data subsequently fed to computers for reduction and analysis. Eight vehicle-mounted transducers monitor inputs of steering, brake, and accelerator, together with vehicle responses of speed and acceleration. A digital computer performs initial data conversion; a larger system handles further processing chores. This equipment and software were developed to study problems of alcohol-impaired drivers, as part of a program backed by the National Inst. on Alcohol Abuse and Alcoholism. The approach, however, could well find application in other studies of the driver/vehicle interface. A copy of a computer printout of a typical set of raw data ob-

tained from a run through straight and curved sections of a test track is presented.

Publ: Automotive Engineering v85 n12 p53-5 (Dec 1977) 1977

Based on SAE-770813 "Measuring Driver Performance: Instrumentation, Software, and Application," by Daniel K. Damkot, Henry A. Geller and David G. Whitmore, presented at Passenger Car Meeting, Detroit, 26-29 Sep 1977. Availability: See publication

HS-022 020

## METHANOL FUEL OF THE FUTURE

Using methanol as a fuel vs. gasoline in four-cylinder engines, higher compression improves relative energy savings at higher speeds, fuel savings improve with spark advance (with performance less affected), volumetric consumption makes relative gains at greater speeds, and energy benefits are retained and engine performance improves with engine revs. In comparing the energy efficiencies of a production gasoline engine, a high-compression methanol prototype engine, and a diesel engine of a very similar type, the methanol engine values are close to those of the diesel with an equality achieved at high-load ranges. The cold-start limit of methanol was much improved by heating and evaporating a small quantity of fuel prior to ignition. The engine's idle behavior was unsatisfactory after cold start. Tests with fully atomized fuel did not improve the starting behavior markedly. Warm-up driveability problems can be solved by additives (e.g. isopentane, dimethyl ether) to straight methanol; however, the comparatively large amount of liquid fuel in the A/F (air/fuel) mixture requires carefully tuned automatic choke devices to prevent failures from wet spark plugs and to avoid too much crankcase oil dilution. In hot-start and high-temperature driveability tests, no major difficulties were encountered even with fuels having RVP (Reid Vapor Pressure) values up to 1.15 bar. The methanol fuel's high heat of vaporization and high mass flow rate satisfactorily control vapor lock problems. More than 100,000 miles have been covered by some methanol-fueled VW Rabbit prototypes with no serious damage.

Publ: Automotive Engineering v85 n12 p48-52 (Dec 1977) 1977

Based on SAE-770790 "Development of a Pure Methanol Fuel Car," by Holger Menrad, Wenpo Lee, and Winfried Bernhardt, presented at Passenger Car Meeting, Detroit, 26-29 Sep 1977. Availability: See publication

HS-022 021

## PROPAGATION OF DISTURBANCES IN TRAFFIC FLOW. FINAL REPORT

The sensitivity of the optimal steady-state traffic distribution (distribution of vehicles in a freeway corridor network to minimize average travel time) to external changes including accidents and variations in incoming traffic was analyzed via dynamic programming. The propagation of external perturbations was studied by numerical implementation of dynamic programming equations. Using modern control theory and graph theory, it is proved that when the traffic network displays a certain regularity and satisfies certain conditions, the effects of imposed perturbations which contribute no change in total flow decrease exponentially as distance from the incident site increases. The impact of perturbations with nonzero

total flow is also characterized. The results of this study confirm numerical experience and provide bounds for the effects as functions of distance.

by Pierre Dersin; S. B. Gershwin; Michael Athans  
Department of Transportation, Transportation Systems Center,  
Kendall Square, Cambridge, Mass. 02142; Massachusetts Inst.  
of Tech., Electronic Systems Lab., Cambridge, Mass. 02139  
Contract DOT-TSC-849  
Rept. No. DOT-TSC-OST-77-62; DOT-TSC-OST-76-50; 1977;  
289p 42refs  
Rept. for Jun 1975-Oct 1976.  
Availability: NTIS

## HS-022 022

### EMISSIONS FROM SYNTHETIC FUELS PRODUCTION FACILITIES. VOL. 2

Descriptions of various types of synthetic-fuel extraction and processing are presented along with detailed discussions of the analytical procedures used to define individual modules and to identify their emissions. With respect to the modules, their sizes were selected to represent typical sizes anticipated for a commercial facility; they allow the synthetic-fuels processes to be compared on an energy-output basis. Air emissions, water effluents, energy recovery, and process requirements for water, manpower, and ancillary energy are discussed for each of the modules. Descriptions are given for both the resource extraction processes and the synthetic-fuel conversion processes. Also included are qualitative discussions of trace-element and organic emissions and effluents. In addition, the water systems are analyzed for potential problems in achieving "zero discharge" of water effluents. Oil-shale extraction modules are presented for surface mining and underground room-and-pillar mining. A module for oil-shale sizing is also included. Oil-shale retorting and upgrading modules are discussed; the types of oil-shale processes studied are TOSCO II, Paraho, and Union Oil. A coal strip-mining module, and Lurgi coal-gasification module for the production of low-, medium-, and high-Btu gas are presented. Proposed water systems for the TOSCO II process and the Lurgi process are examined for potential problems in achieving zero discharge as well as the potential advantages and disadvantages of treatment of water effluents to a quality which may be discharged. Based on the analysis of a representative oil shale project's water system, there appear to be no major problems confronting the application of their proposed water reuse strategies. The systems will mainly need to guard against scaling in their shale moisturization process. They will also need to clean their foul process water sufficiently to remove ammonia gas, hydrogen sulfide, and phenols before using it to moisturize spent shale. A Lurgi water system appears to have greater dangers of running into problems as a result of its relative complexity. Potential exists for scaling in the piping for the minor Phenosolvan stream (the gas cleaning effluent liquor), in the piping and vessels used to feed the various process blowdowns to the brine concentration system, and in the ash sluicing system. Whether or not these problems occur will depend on the specific nature of the coal used and the actual flow conditions, such as retention times for vessels and lines. Odor

problems may also arise from absorbed ammonia gas, hydrogen sulfide, and phenols in the ash sluice liquor.

by J. D. Colley; W. A. Gathman; M. L. Owen  
Radian Corp., Austin, Tex.  
Contract EPA-68-01-3535  
Rept. No. EPA-908/4-77-010B; DCN:77-100-092-01; 1977; 217p  
49refs  
See also EPA-600/2-76-064, a companion study.  
Availability: Environmental Protection Agency, Region 8,  
Denver, Colo.

## HS-022 023

### DUAL CONVERTERS CUT TWO-STROKE HYDROCARBONS

Refinements which were made to Suzuki's two-stroke engine in order to meet Japan's stringent 1978 automotive emission standards are described. In particular, the two-stroke engine presented a problem because of a disproportionately high output of hydrocarbons (HC). Quenching of a two-stroke's gasoline/oil blend and "mixture short circuitry" are usually thought responsible for these excessive emissions. The latter, taking most of the blame, is a by-product of two-stroke scavenging; with transfer and exhaust ports open simultaneously, as much as 25%-40% of an incoming charge exits in an unburned state. The HC problem is compounded by the fact that two-stroke exhaust temperatures tend to be relatively low; thus, after-treatment by thermal reaction (popular in Japan) is only partly successful in this application. Catalytic converters have been used with two strokes, but HC richness tends to reverse the temperature picture downstream; excessively high converter temperatures play havoc with catalyst durability. Presented with these challenges, Suzuki's engineers developed a three-part program for controlling two-stroke emissions. The control approach to this emission problem uses dual catalytic converters, relatively high proportions of secondary air injection, and an improved palladium catalyst. Two monolithic elements split up catalytic activity in the interest of reduced temperature and enhanced converter durability. Secondary air keyed to engine load also minimizes thermal stress. Improvements in catalyst formulation prevent retreat of active material from the catalyst surface. The complete package, Suzuki's E-SS12 minicar, is a rear-engined sedan with 203-cm wheelbase and curb weight around 530 kg. Its three-cylinder, two-stroke engine displaces 433 cc, with maximum output of 24 hp at 4500 rpm. Initial testing indicates that the car could meet 1980 California emission standards as well.

Publ: Automotive Engineering v85 n12 p43-6 (Dec 1977)  
1977  
Based on SAE-770766 "Emission Control of Two-Stroke  
Automobile Engine," by Hisao Uchiyama, Takahiro Chiku,  
and Shigemasa Sayo, presented at Off-Highway Meeting,  
Milwaukee, 12-15 Sep 1977.  
Availability: See publication

## HS-022 038

### INTERNATIONAL CONFERENCE ON VEHICLE STRUCTURAL MECHANICS (2ND) PROCEEDINGS, APRIL 18-20, 1977, SOUTHFIELD, MICHIGAN.

are concerned with collision and plasticity, structural design, analytical techniques, structural optimization, and component analysis and design. Collision and plasticity studies deal with analysis of thin shells by flow theory, validation of crash simulation, crushing of box columns, and a method for analyzing frontal crush strength. Papers on structural design include studies on modeling techniques for ride and vibration improvement, finite element methods, analysis of an experimental structure, and the development of structural models. Analytical techniques considered include the following: stress and dynamic analyses of viscoelastic cylindrical block; mesh refinements of discrete element analysis; inelastic stresses in a rolling contact; and substructuring of localized plasticity analysis. Other techniques considered include systems design with substructures, inertia relief used to estimate impact loads, finite element methods in stress analysis, and isoparametric finite elements in structural mechanics. Structural optimization procedures include experiences with minimum weight design using optimality criteria methods, the application of these techniques to automotive crashworthiness and truck ride improvement problems, and to panel design. Component analysis and design experiments cover the effect of transverse forces on shrink-fit assemblies, the impact vibrations of rolling tires, finite element and laboratory strain analyses of a cast steering knuckle, and elastic-plastic finite element analysis of vehicle structure components.

Society of Automotive Engineers  
Rept. No. SAE-P-71; 1977; 254p refs  
Includes HS-022 039--HS-022 062.  
Availability: SAE

HS-022 039

# **ELASTO-PLASTIC AND LARGE DEFLECTION ANALYSIS OF THIN SHELLS BY THE FLOW THEORY OF PLASTICITY**

A previously reported mathematical model of thin shells was used for sheet metal response to impact loads. Based upon nonlinear shell theory, the flow theory of plasticity, and the finite element technique, the equilibrium conditions in the incremental form at each nodal point are established. Step-by-step numerical integration is applied to solve these equations and an error control procedure is incorporated at every load level. A computer program has been written according to this formulation and development. It was checked by running two sample problems for which solutions exist in the literature and one problem whose solution was experimentally evaluated from a full size structure. In addition applications relative to finding the dent resistance and oil-canning deformations of sheet metal body components in an automotive structure are discussed. Much computer time will be required for the program to reach the maximum load level, but this method is still recommended as more time/efficient than the previously re-

Ford Motor Co.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p1-8  
Rept. No. SAE-770590; 1977; 7refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 040

# **DYNAMIC VALIDATION OF A COMPUTER SIMULATION FOR VEHICLE CRASH**

Two crash tests are described, designed to validate a computer simulation developed for predicting the large dynamic plastic response of vehicle structures under crash conditions. The test structures were idealized quarter scale models consisting of frame and rigid body elements. Both direct and oblique pole impacts are reported. Impact speed was 30 mph. Predicted and experimental results are compared for the crush displacements, impact force at the pole barrier, and acceleration histories at two points on the "passenger compartment" mass. Good agreement is obtained for the symmetric test. Results for the oblique test are not as uniformly good, but quantitative agreement is still satisfactory. Comparison of dynamic variables are sensitive to both the filtering of the raw test data and the numerical integration procedure employed in the simulation. The use of appropriate error measures to select step size insures the efficient convergence to a signal with the frequency content of interest in crashworthiness applications.

by I. K. McIvor; W. J. Anderson  
University of Michigan  
Contract DOT-HS-4-00855  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p9-17  
Rept. No. SAE-770591; 1977; 7refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 041

# **DYNAMIC CRUSHING OF STRAIN RATE SENSITIVE BOX COLUMNS**

An appropriate analysis is presented from which dynamic strength and energy absorption of axially loaded thin-walled box columns can be determined by identifying main mechanical and geometrical parameters in the problem of impact loading of sheet metal, and by deriving an expression for the strain rate correction factor. The dynamic compressive force is a product of a static crushing strength of the column and a strain rate correction factor. The static crushing strength was shown to be proportional to the static yield stress and the square of the wall thickness as well as being dependent on the ratio of a longer to shorter side of a rectangular section. A good correlation of the load-deflection relationship and mean static crushing strength with experiments was obtained provided the effect of strain-hardening is properly taken care of. Insufficient experimental data exist, however, to validate the

## HS-022 042

present theory in the much wider range of section dimensions and impact velocities.

by Tomasz Wierzbicki; Ture Akerstrom  
General Motors Corp., Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p19-31  
Rept. No. SAE-770592; 1977; 10refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

## HS-022 042

### A DESIGN-ANALYSIS METHOD FOR THE FRONTAL-CRUSH STRENGTH OF BODY STRUCTURES

A simplified design-analysis method is developed for estimating the ultimate load-carrying capacity and the associated collapse mechanism of a body structure subjected to a frontal crush load. The analysis is based on the principles of limit analysis; the computation scheme consists of repeated stepwise analyses for each incremental load, and repeated searching for the collapse mechanism which requires the least load (the collapse load). Very good agreement was obtained between analysis and crush-test results of production body structures. This design analysis method provides a simple and direct means for design engineers to evaluate the effect of design variations on the body crush strength.

by David C. Chang  
General Motors Corp., Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p33-41  
Rept. No. SAE-770593; 1977; 8refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

## HS-022 043

### SYSTEM MODELING TECHNIQUES TO IMPROVE THE RIDE AND VIBRATION ISOLATION CHARACTERISTICS OF HEAVY EQUIPMENT

A practical computerized design approach is provided to advance work on vehicle dynamics relative to human response ride criteria. The vehicle designer selects a representative terrain input, either sinusoidal or power spectral density (PSD), to produce a vehicle model constructed by the modal Building Block method. To evaluate vehicle ride the resulting system response, accounting for human dynamic characteristics, is compared to accepted ride criteria, such as International Standards Organization (ISO) spectra and absorbed power. An example involving an agricultural tractor is presented to illustrate the approach. The effects of an attached trailer may be included in the system model as an additional Building Block (either rigid or flexible) with appropriate suspension systems and PSD phasing. Passive vibration isolation design, such as elastomeric mounts, are inadequate for tractor-trailer systems; active vibration isolation control systems employing hydraulics or pneumatics may be necessary. These simulation methods may be extended to encompass such systems. Vehicle design includes not only considerations of ride, but also handling,

structural integrity (fatigue life), crashworthiness (ROPS), and noise reduction, all within weight, manufacturability, and cost constraints.

by Ronald A. Shryock; Joseph W. Klahs; David A. Dieterich  
Structural Dynamics Res. Corp.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p45-57  
Rept. No. SAE-770594; 1977; 29refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

## HS-022 044

### NOVEL DEVELOPMENTS AND APPLICATIONS OF FINITE ELEMENT METHODS AT DAIMLER-BENZ

New finite element (FE) software and application developments at Daimler-Benz since 1974 are surveyed. Applications of FE analysis in the organization include computation support to design and testing, decentralized computation groups, centralized computer hardware and software, FE systems NASTRAN and ESEM/TPS10, in-house and outside software development, and verification and efficiency tests. Featured in these organizational applications are the Programm für GROSSE VERSchiebungen (GROVER) for geometrically nonlinear problems (large displacements, small strains), the MSC/NASTRAN superelement capability, the hybrid (modal/direct) frequency response analysis of full car simulations, and a remarkable mesh and data generator. Examples of design applications cover spring and axle systems under large displacements, the over/understeer characteristics of an off-road truck, the frequency spectrum of stress amplitudes in a loaded bus, and a turbine blade static and dynamic analysis. This FE method is an integral part of vehicle development at Daimler-Benz and contributes to product improvement by permitting quick decisions on design problems.

by D. Radaj; A. Zimmer; H. Geissler  
Daimler-Benz AG, Germany  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p59-68  
Rept. No. SAE-770596; 1977; 10p 16refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

## HS-022 045

### DESIGN THROUGH ANALYSIS OF AN EXPERIMENTAL AUTOMOBILE STRUCTURE

It is evident that the use of impact simulation, static, and dynamic analyses in the preprototype phase of the design process can significantly improve the structural efficiency of the automobile. As a result of this design project, the accuracy of the structural modeling and analysis was verified by experimental data obtained from a fabricated test vehicle, and the potential value of design through analysis was demonstrated by a significant reduction in structural weight of the project vehicle. This was accomplished within prescribed safety and operational load requirements, as well as prescribed packaging requirements and overall dimensions. Conclusions which may be applicable to only the vehicle studied are the following: barrier impact and safety load conditions were found to design

by James A. Augustus, Mount T.M. Kamal; Larry J. Howell  
General Motors Corp. Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p69-81  
Rept. No. SAE-770597; 1977; 13refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 046

#### A FEW ASPECTS ON THE DEVELOPMENT OF STRUCTURAL MODELS

The Finite Element System (FES) is described as used by Adam Opel AG, employing a SIGMA-6 computer, plotter, drafting machines, and graphic video displays. The finite element method is a useful tool for analyzing vehicle and chassis components even if no large computer or interactive communications are available. Creation of structural models, finite element calculations, and evaluation of results are outlined. Examples of calculations in the body-shell and chassis field are included. The preferential use of beam and shell elements in the generation of finite element models has the great advantage that the model is easily changeable; however, increased care is necessary to avoid beam joints which are too stiff. The finite element method is successful in vehicle structural development only when the results are reliable and quickly available. Introduction of an interactive graphical system is expected to provide improvements in this method.

by Klaus Hieronimus  
Adam Opel AG (Germany)  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p83-95  
Rept. No. SAE-770598; 1977; 9refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 047

#### STRESS AND DYNAMIC ANALYSES OF A BONDED, NON-LINEAR VISCOELASTIC CYLINDRICAL BLOCK

An approximate theoretical treatment is presented for the large deformation of nonlinear viscoelastic cylindrical blocks bonded between rigid end-plates. The measured compressive force relaxation of two blocks of different initial radius to height ratios is shown to be in good agreement with the theoretical predictions for a carbon-black filled vulcanizate. Measurements of dynamic stiffness for various compressive pre-loads and a frequency range of .05 to 30 Hz were also conducted. The measured values for the storage stiffness are shown to be in good agreement with the theoretical predictions, but poor correlation between experiment and theory is obtained for the loss stiffness. These discrepancies are attributed to approximations in analysis made necessary by lack of computer codes for more exact treatment. The method is

ROBERT A. PETT  
Ford Motor Co.  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p99-110  
Rept. No. SAE-770599; 1977; 6refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 048

#### USER ORIENTED MESH REFINEMENTS IN THE DISCRETE ELEMENT ANALYSIS TECHNIQUE

A review is presented of recent advances in optimum grid solutions, in which idealization geometry is included as a variable in finite element solution procedure. Elements in the theoretical foundation of the optimum grid solution are outlined, such as the formulation of the elastostatic problem, a method for formulating the elastodynamic and elastic stability problem, and the physical characteristics of this solution. User-oriented guidelines from the published literature are reviewed, including a comparative evaluation of criteria used to direct mesh refinement. Grid optimization can play a substantial role when dealing with problems associated with the behavior of singularities. Near optimum meshes will not in general satisfy the optimum grid equations. Near optimum approaches currently in use include the isoelement concept, the local residual vector technique, and the strain energy gradient concept. As for error detection and convergence in grid optimization, a necessary condition for convergence is the vanishing of the residual factors. A recommended mode of grid optimization is suggested, and exemplified by the case of a cantilevered beam problem.

by W. E. Carroll  
Florida Technological Univ.  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p111-9  
Rept. No. SAE-770600; 1977; 12refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 049

#### NUMERICAL INVESTIGATION OF STRESSES IN THE INELASTIC RANGE IN A ROLLING CONTACT

An automobile component moving in a rolling contact is modeled as a disk rolling on a rigid track. Elastic-plastic finite element method is used to determine the stresses and strains in the disk near the point of contact as a function of the rolling history. It is shown that unloading due to rotation of the previously yielded elements can be easily handled by the direct stiffness tangent modulus approach. Stresses at shakedown and elastic-plastic steady state are computed. The technique can be easily applied to more refined finite element models of cams, camshafts, roller ball bearings, and other automobile components. Any load history can be easily programmed to determine whether the resulting stresses are in a shakedown state or lead to alternating (or incremental) plasticity.



ty. Analyses like these can be helpful in understanding the phenomenon of plastic fatigue failures.

by Subhash C. Anand

Clemson Univ.

Grant NSF-GK-37150

Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p121-7

Rept. No. SAE-770601; 1977; 12refs

Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.

Availability: In HS-022 038

HS-022 050

## A SUBSTRUCTURING APPROACH TO LOCALIZED PLASTICITY ANALYSIS

A technique is discussed which substantially reduces the cost of the nonlinear analysis of complex structures with areas of localized plasticity. The technique is based on the premise that the yielding is confined to small areas and that the bulk of the structure behaves elastically, resulting in only small displacements to the structure. The basis of the technique is the substructuring of the localized plasticity areas. They are identified and disconnected from the linear elastic part of the model by boundary points. The elastic degrees of freedom are reduced to boundary freedoms having boundary stiffness matrices which remain constant for each incremental step of a plasticity solution. The displacements for the last incremental step may be used to verify that the linearity of the elastic substructure has not been violated. Two currently used finite element codes, SATURN and ELAPSE, which operate within the IMAGE system, were modified for this procedure. These computer programs are briefly described and the technique, accuracy, and savings are compared to a complete nonlinear analysis, using two simple structures. Finally, the method is applied to a detailed automotive component.

by Richard B. Katnik; Michael F. Kowalski; Kuo-Kuang Chen

Chevrolet Engineering Center; General Motors Res. Labs.

Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p129-38

Rept. No. SAE-770602; 1977; 17refs

Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.

Availability: In HS-022 038

HS-022 051

## SYSTEMS DESIGN WITH SUBSTRUCTURES

After a brief discussion of the theoretical basis of substructures for statics and dynamics, the handling techniques are described, including file management, modification utilities, and nested hierarchies. Examples of recent applications illustrate the economies that can be achieved by substructuring. Substructures are especially economical in repetitive analyses, such as nonlinear static and dynamic analyses in which major portions of the structure exhibit linear behavior, or in design studies where only a portion of the model is to be modified. Substructuring is not generally economical in single load case static analyses but it may be necessary in some cases of very complicated models, in order to analyze them within available computer resources. Advantages of substructuring include reduced computer time, the feasibility of increased problem

size, more direct communication between systems and component analysis, symmetry, repeatability, and hierarchy. Among the disadvantages are increased file handling, more computer runs, loss of accuracy for dynamic problems, limitation to linear models within substructures, and reduced computer-to-computer mobility. The principles of substructuring are extended to include transient thermal analyses, which may be coupled to substructured stress analyses. The role of substructures as an intergroup communication tool is outlined.

by Cecil R. Rogers

Swanson Analysis Systems, Inc.

Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p141-8

Rept. No. SAE-770603; 1977; 13refs

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Availability: In HS-022 038

HS-022 052

## THE USE OF INERTIA RELIEF TO ESTIMATE IMPACT LOADS

Several examples are examined to determine the accuracy of the inertia relief method for calculating dynamic forces in a structure. The dynamic responses of simple series-connected and parallel-connected spring-mass systems are analyzed and compared with inertia relief calculations. An important conclusion is that for masses connected in series, the error in the inertia relief results increases as one gets farther from the applied load. The final example is a space frame structure composed of welded tubular elements and representing a subcompact vehicle geometry. It is subjected to a load which is similar to that resulting from the 8 km/h (5 mph) bumper impact safety standard.

by Mark F. Nelson; Joseph A. Wolf, Jr.

General Motors Corp., Res. Labs.

Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p149-55

Rept. No. SAE-770604; 1977; 7refs

Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.

Availability: In HS-022 038

HS-022 053

## FINITE ELEMENT METHOD IN STRESS ANALYSIS PRACTICE

The approximate nature and model dependent character of the finite element method are explored. To solve practical engineering problems using general purpose finite element computer codes such as NASTRAN, ANSYS, or SDCR SUPERB, stress analysts must be concerned with selecting appropriate and cost-effective finite elements, with using good modeling techniques to obtain a cost-effective finite element model, with interpreting computed displacements, stresses, and strains and assessing their accuracy, and with developing and evaluating necessary design changes. Modeling strategies and selection of appropriate finite element types are explained and the procedures are illustrated with several examples. Finally, the solutions of two practical stress analysis problems are discussed in detail to demonstrate the proper utilization of the finite element method in real world applications. A stress

analyst must establish clear objectives, have at least an approximate idea of how the structure will behave, and have basic knowledge concerning the theoretical basis and properties of various finite element types in order to use the finite element method in a cost-effective manner.

by E. Cütipitoglu; V. T. Nicolas; S. K. Tolani  
Structural Dynamics Res. Corp.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p157-72  
Rept. No. SAE-770605; 1977; 13refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 054

# **APPLICATION OF ISOPARAMETRIC FINITE ELEMENTS IN VEHICLE STRUCTURAL MECHANICS**

The basic concepts and the techniques used in developing a family of isoparametric elements having linear and parabolic displacement variations, and a suitable combination of the same, are discussed. Isoparametric elements having additional nodes along their sides have a significant practical advantage in that such sides can be allowed to distort physically to represent the true geometrical configuration of a structure. Also, the accuracy of results and the rate of convergence of solution can be increased even with larger, and consequently fewer, elements. Comparative models using the conventional and isoparametric elements are presented to illustrate their differences: static analysis, dynamic analysis, transient heat conduction analysis, and analysis of torsional problems. With the use of isoparametric elements, the finite element representation of any large complex system is tremendously simplified and a very economical solution can be obtained. There is a possibility of misuse with unreasonably distorted elements. Methods of detecting them are mentioned and appropriate recommendations for avoiding them are given. The merits of using the isoparametric elements for complex two-dimensional, three-dimensional, and general shell structures are illustrated with examples of applications to a large variety of vehicle components, including the following: exhaust manifold; automobile spider wheel; truck frame; radius arms; rack and pinion steering housing; axle housing; steering knuckle arm; gear tooth; and front sill segment.

by C. J. Parekh; J. E. Basas; K. S. Kothawala  
Engineering Mechanics Res. Corp.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p173-87  
Rept. No. SAE-770606; 1977; 14refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 055

# **EXPERIENCES WITH MINIMUM WEIGHT DESIGN OF STRUCTURES USING OPTIMALITY CRITERIA METHODS**

A summary of methods is presented, based on optimality criteria, to design minimum weight built-up structures such as trusses and frames within stress, displacement, buckling, and

dynamic stiffness constraints. Two main steps in optimization are analysis of the structure to determine its response to applied loads and redistribution of the material in the members of the structure to reduce weight. Five examples are given to show the applicability of methods to design a minimum weight structure within different types of constraints: ten-bar truss with stress constraints, then with displacement constraints; unsymmetric rectangular frame; circular arch with impulse load; and three-dimensional dome, general stability. The optimality criteria and the necessary recurrence relations are derived for each of these design constraints. The methods based on optimality criteria can be used to design structures with multiple loading conditions and multiple constraints. They use an iterative procedure, modifying the design variables by using a recurrence relation during each iteration. The number of iterations needed to arrive at the minimum weight is independent of design variables. Computations required for resizing are only a little more than the analysis itself.

by N. S. Khot; V. B. Venkayya; L. Berke  
Wright-Patterson Air Force Base, Air Force Flight Dynamics Lab.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p191-201  
Rept. No. SAE-770607; 1977; 15refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 056

# **THE APPLICATION OF OPTIMIZATION TECHNIQUES TO PROBLEMS OF AUTOMOTIVE CRASHWORTHINESS**

The use of optimization methods can improve vehicle design for front-end structural stiffness in order to meet barrier impact standards. An improved impact simulation model which calculates the steering column development is introduced. To express the effect of passenger compartment deceleration on potential injury, a vehicle crash severity index is introduced and is shown to be positively correlated with potential injury based on the chest severity index. An optimization technique is used to find a set of design variables which will satisfy constraints placed on the above measures of crashworthiness; namely, the steering column envelopment and the vehicle crash severity index. The shape similarity of force-deformation curves from car to car for a given component suggests the use of a scale factor on the curves as a design variable. These techniques may be used for multiple, even competing, objectives. They enable an engineer to predict the performance of a system and to modify the system toward user specified limits. Appended is a description of the front end barrier impact simulation (FEBIS) model.

by James A. Bennett; Kuang-Huei Lin; Mark F. Nelson  
General Motors Corp., Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p203-10  
Rept. No. SAE-770608; 1977; 5refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 057

## TRUCK RIDE IMPROVEMENT USING ANALYTICAL AND OPTIMIZATION METHODS

A method is presented for analytically studying truck ride improvement in order to identify the modes of vibration which contribute to driver discomfort and fatigue and to create and verify prospective design improvements. A two-tier approach is applied to the analysis of a cab-over-engine tractor. A detailed three-dimensional finite element model was developed and verified with data acquired from road input. In addition, a simpler two-dimensional model was developed and used with an optimization technique to develop alternative designs. The root-mean-square (rms) accelerations of the driver in the vertical and fore-aft directions were used as performance measures. The proposed designs were then evaluated using the detailed finite element model, and additional improvements were suggested. This approach led to a modification of the cab mounting system which resulted in a predicted 44% reduction in the fore-aft rms acceleration from an initial design. From the modes of vibration identified, it is shown that to model the tractor correctly it is necessary to include cab mount flexibilities, frame flexibilities, and an accurate model of the tandem rear suspension. Because the optimization had identified the solution, further detailed model computer runs were not required for verification, resulting in a considerable financial saving.

by J. H. Baum; J. A. Bennett; T. G. Carne  
General Motors Corp., GMC Truck and Coach Div.; General Motors Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p211-20  
Rept. No. SAE-770609; 1977; 19refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 058

## STRUCTURAL OPTIMIZATION IN PANEL DESIGN

The use of structural optimization techniques in vehicle design relieves the designer of much of the computational burden, thus shortening the design cycle time. This methodology can also serve as a tool for finding and evaluating minimum weight structures. Major emphasis is placed on design applications and on the development of a practical and efficient lightweight design-search system for vehicle structural panel designs. This allows the system to be formed more effectively in adopting special analysis schemes, design considerations, and optimization algorithms to fit the vehicle structural design requirements. The relative merits and disadvantages of computer adaptations of some of the more promising algorithms are also discussed. Solutions to some specific minimum weight example problems pertaining to reinforced automotive panel design are presented. Results are obtained for both homogeneous and bimaterial panel assemblies. Minimum allowable structural performance criteria are enforced through nonlinear constraint equations. Numerical results are obtained using a lightweight design-search system (LDSS) currently under development. Applications of the system to panel problems appear to be

cost effective and modifications are expected to achieve comparable results in more complex situations.

by David C. Chang; Martin R. Barone  
General Motors Corp., Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p221-9  
Rept. No. SAE-770610; 1977; 15refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 059

## EFFECT OF TRANSVERSE FORCES ON SHRINK-FIT ASSEMBLIES

The stresses of transverse forces on shrink-fit assemblies are identified as radial pressure and tangential stresses due to the interference, and axial and shear stresses due to bending movement and torque. The effect of these forces is studied using isoparametric solid finite elements. The shrink-fit is simulated in the computer by keeping the coefficient of thermal expansion of one of the parts as zero and heating the whole assembly to desired temperature. The transverse forces tend to loosen the joint and if they are sufficiently large, joint effectiveness will be completely lost. For a minimum fit in the presence of transverse forces, the following factors must be considered: ratio of crushing stress to radial pressure to prevent the joint from coming loose; maximum amount of torsion that can be transferred by the fit; stress concentration factors due to change in section; and fatigue consideration due to fretting action for fully reversing transverse loads. Checking of load values at coupled nodes showed that, for higher order isoparametric elements, loads alternate between tension and compression. Linear elements, however, were shown to have forces in accord with commonsense observation.

by T. V. Seshadri  
Fruehauf Corp.  
Publ: HS-022 038 (SAE-P-71), "International Conference on Vehicle Structural Mechanics (2nd) Proceedings," Warrendale, Pa., 1977 p233-43  
Rept. No. SAE-770611; 1977; 6refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr 1977.  
Availability: In HS-022 038

HS-022 060

## IMPACT VIBRATIONS OF ROLLING TIRES

In-plane (horizontal and vertical) tire vibrations result from "impulsive" input forces which result when tires impact small or cleat-like bumps (e.g. tar strips). Such high frequency vibrations (20-100 Hz) are commonly associated with vehicle harshness. Quantitative information relating output spindle forces to different clear inputs is obtained from rolling drum experiments on radial tires. The horizontal and vertical spindle forces do not vary linearly with respect to cleat thickness. The conventional tire models used in ride analysis not only assume linearity with respect to a vertical terrain input but express the longitudinal vibration response in terms of a single torsional carcass resonance. These models may be adequate for analyzing low frequency (20-30 Hz) vibrations excited by long wave length terrain disturbances; they cannot, however, predict wheel-plane vibrations that occur when a tire impacts sharp

by Martin R. Barone  
General Motors Corp., Res. Labs.  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p245-52  
Rept. No. SAE-770612; 1977; 8refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 061

#### CAST STEERING KNUCKLE FINITE ELEMENT AND LABORATORY STRAIN ANALYSIS

The finite element method, a computerized approach to structural design analysis, was evaluated by analyzing a cast steering knuckle using both finite element strain analysis and laboratory strain analysis. Calculated strain levels correlated well with the strain gage measurements. Strain contours calculated by the finite element method showed good correlation with laboratory stresscoat tests. Assuming an equivalent level of skill, the time required for an initial design evaluation would be ten weeks for laboratory analysis and seven weeks for finite element analysis, the cost for the latter being 1% higher. To evaluate a redesign, 33 days would be required for laboratory analysis and six days for finite element analysis, the cost for the latter being possibly 8% lower. Skills required for finite element analysis are those of a keypunch operator, a draftsman, and a design engineer with knowledge of applied analytical mechanics.

by William L. Felske  
General Motors Corp., Central Foundry Div.  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p253-62  
Rept. No. SAE-770613; 1977; 2refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 062

#### ELASTIC-PLASTIC FINITE ELEMENT ANALYSIS OF VEHICLE STRUCTURAL COMPONENTS

Two practical finite elements are examined, a beam element and a triangular plate bending element, to determine how they can be applied to vehicle design analysis with acceptable accuracy, yet without expensive computer time penalty. These elements have been implemented in a special purpose program for nonlinear stress analysis of automotive structural components. The program employs an initial strain approach, a convected coordinate procedure, and an incremental technique to monitor both geometric and material nonlinearities. Three example problems of sheet metal panel and chassis components are defined as to descriptions of material properties, boundary conditions, and loads, in order to make meaningful the correlation between analysis and experimental data. This correlation indicates that the program, with proper modifica-

Chevrolet Engineering Center  
Publ: HS-022 038 (SAE-P-71), "International Conference on  
Vehicle Structural Mechanics (2nd) Proceedings," Warrendale,  
Pa., 1977 p263-6  
Rept. No. SAE-770614; 1977; 20refs  
Presented at the Conference, Southfield, Mich., 18-20 Apr  
1977.  
Availability: In HS-022 038

HS-022 100

#### EFFECTS OF DECELERATION AND RATE OF DECELERATION ON LIVE SEATED HUMAN SUBJECTS. FINAL REPORT

Seated passengers can safely experience deceleration levels about twice those reported for standees. Testing was conducted of live, seated human subjects to determine the maximum deceleration and associated rate of change of deceleration (jerk) at which the majority of potential users of automated guideway transportation (AGT) systems can remain securely in their seats. Subjects underwent various levels of deceleration and associated jerk in an instrumented vehicle; they were decelerated while seated normally (forward-facing), sideward (turned 90° counterclockwise from the direction of travel) and normally, but tilted backward (facing forward but with the entire seat tilted 5° backward). Subjects also underwent various levels of jerk while seated normally only. Two groups of subjects were chosen to represent anthropometric extremes of potential passengers: males larger than 90% of the male population, and females smaller than all but 10% of the female population. Based on these tests, an estimate of the maximum permissible emergency deceleration for forward-facing, seated AGT passengers is 0.47 g, and for side-facing passengers, 0.41 g. Tilting the entire seat assembly backward 5° increased the estimated maximum permissible deceleration to 0.52 g.

by C. N. Abernethy; G. R. Plank; E. D. Sussman  
Transportation Systems Center, Kendall Square, Cambridge,  
Mass. 02142  
Rept. No. UMTA-MA-06-0048-77-3; DOT-TSC-UMTA-77-44;  
1977; 26p Srefs  
Rept. for Oct 76-Sep 77.  
Availability: NTIS

HS-022 102

#### MOTOR CARRIER ACCIDENT INVESTIGATION. FREPORT TRANSPORT, INC. ACCIDENT, MARCH 11, 1977, BAXTER, CALIFORNIA

On 11 Mar 1977 at 2:50 P.M. on Interstate 80 near Baxter, Calif., a tractor trailer combination (also referred to as "the steel truck") operated by Freport Transport, Inc., of Clearfield, Utah, ran out of control on a steep downgrade. The steel truck collided with the rear of a car, then ran off the left side of the road, crashing into a cut slope. The load of steel rails shifted and fell from the truck. The driver of another car, attempting to avoid the flying debris, collided with a parked pickup truck. The truck driver and two unauthorized passengers were ejected. The result was two fatalities (the passengers), one injury, and \$40,000 property damage. Probable cause of the accident was the operation of a heavily loaded

commercial vehicle by an inexperienced driver, unfamiliar with the terrain, coupled with deficient brakes. Though the tractor, leased to the motor carrier, was in poor mechanical condition, the motor carrier's safety director either failed to note or overlooked these deficiencies and certified the vehicle to be in good mechanical condition; no brake deficiencies were noted. The driver had been driving for one week prior to this involvement. Though he claimed 3.5 years truck driving experience, investigation revealed he had only driven one trip for a previous motor carrier, and had been given only a short driving test by the motor carrier. He had neglected to check his brakes in spite of three opportunities in the mountainous area, and claimed he was not aware that smoke was being emitted from his vehicle on the downgrade. It is noted that the Manual on Uniform Traffic Control Devices contains recently revised standards for signing descending grades. Signing variations still exist from state to state; conformity with the revised advisory standards by state authorities is recommended to minimize adverse effects of vehicle operation on downgrades. It is also recommended that motor carriers strive to improve hiring practices, not dispatch inexperienced drivers with deficient equipment, and make certain that persons responsible for the inspection of equipment are both competent and aware of the consequences of failing to make meaningful inspections. The accident should serve as a warning to hitchhikers and other unauthorized passengers of the dangers involved in riding with a truck driver of unknown driving capabilities.

Bureau of Motor Carrier Safety  
Rept. No. BMCS-77-2; 1977; 18p  
Availability: Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590

## HS-022 103

## CURRENT DEVELOPMENTS AND FUTURE TRENDS IN ROAD SAFETY IN AUSTRALIA

A survey is presented of road safety developments at the national level, and the way in which the Australian Dept. of Transportation is involved. The great improvement since 1970 in Australia's road safety record largely stems from the effectiveness of legislation making seatbelt wearing compulsory, firstly in Victoria in 1970 and throughout the country in 1972. The Australia Transport Advisory Council investigates transport problems and coordinates national efforts to improve road safety through vehicle design, traffic law, and education. Design rules are drafted by the Advisory Com. on Safety in Vehicle Design and submitted for comment to industry and representatives of users. Improvements are sought in occupant protection, traffic management, road design, and planning; traffic safety has also been enhanced by the greater use of signs and signals to control intersections. Programs to modify road user behavior are increasingly seen in context with other countermeasures and subjected to rigorous investigation of effectiveness. Abuse of alcohol, however, remains the major contributing factor in serious road accidents.

by J. H. W. Permezel  
Commonwealth Dept. of Transport, Rd. Safety Branch,  
Australia  
1976; 33p  
Paper presented to SAE (A) Convention, Perth, Australia, 20  
Sep 1976.  
Availability: Corporate author

## HS-022 104

## ROAD SAFETY DEVELOPMENTS IN AUSTRALIA

In the Australian Federal system, coordination of transport at the national level, embracing road safety, is facilitated by the Australian Transport Advisory Council (ATAC) and associated committees. ATAC and its specialist committees receive technical and secretariat support from the Commonwealth Dept. of Transport. Other aspects of Commonwealth involvement include assistance to the states for road construction and traffic management; the promotion of safety in vehicle design; coordination of education and publicity programs; and the conduct of research, both fundamental and evaluative. The work of the Expert Group on Rd. Safety and the House of Representatives Standing Com. on Rd. Safety concerned the need for national action in countermeasures against the use of alcohol by road users, an improved system of accident information, and national coordination of road safety efforts. Road accident fatalities have been held below the record 1970 level since the wearing of seat belts was made compulsory. Although seat belts offer a high degree of protection in frontal collisions there is still a need to reduce intrusion into the vehicle occupant space in other types of impact and to implement known measures for the removal, guarding or redesign of roadside objects. Research into the fundamental nature of driver behavior is seen as a prerequisite to effective modification of accident-related behavior. The way in which the evaluation of countermeasures has been pursued is discussed with special reference to recent publicity campaigns.

by C. W. Freeland  
Commonwealth Dept. of Transport, Land Transport Policy  
Div., Australia  
1976; 27p  
Presented to New Zealand Traffic Safety Res. Seminar,  
Wellington, 29 Apr-1 May 1976.  
Availability: Corporate author

## HS-022 118

## EVALUATION OF A HUB ASSEMBLY. PT. 2

The description is concluded of an automatic simulator and test schedule for wheel bearing assemblies, devised to represent true driving conditions. The detection of bearing failures by an accelerometer placed on each test hub was improved by using hardened steel tires for the dummy wheel and by altering the speed away from any possible resonance. No corrugations have developed since and at 1000 rev/min, corresponding approximately to 100 km/h vehicle speed, the rig runs smoothly with little background noise or vibration. Bearing fatigue failure can be detected consistently at an early stage. In testing for life expectancy, comparing the performance of different designs and evaluating the effect of changes in design or material, a sample size of 32 is used for the wheel hub tests. In the "replacement" fatigue test, four hubs are tested simultaneously on one rig; when one fails it is replaced and the test continues until a sufficient number of failures has been obtained. In the "sudden death" test, samples of 32 are divided randomly into eight groups of four, each of which is run simultaneously on one rig until the first failure occurs in the group, after which that group is suspended. The test will provide eight results, each representing the least of its group. This method considerably shortens the test time and, from a statistical point of view, by revealing earliest failures in each group, takes a short cut and extracts information about a sample fatigue life in predicting occurrences of early failures.

For three years numerous tests have been conducted with two rigs on all types of hub assemblies, with practical application of the results on current and future models.

by S. Y. Poon; S. G. Williams  
 Publ: Automotive Engineer v2 n5 p33-4 (Oct/Nov 1977)  
 1977; 2refs  
 For Pt. 1 see HS-021 480.  
 Availability: See publication

HS-022 119

## 1974 NATIONAL TRANSPORTATION REPORT. URBAN DATA SUPPLEMENT

Detailed urbanized area data which form the basis for numerous statistical tables in Ch. 5 of the 1974 National Transportation Report (NTR), an analysis of urban transportation plans, programs, and alternatives submitted by state and urbanized areas in response to the 1974 National Transportation Study (NTS), are presented. In addition, some new material is presented which was not available for the NTR. The data for the following are three reporting periods: 1972 Inventory, 1972-1990 Plan, and 1972-1980 Program. For the 1972 Inventory the states were asked to report on the transportation system as it existed on 1 Jan 1972. Data involving highway and public transportation operations (e.g. annual operating costs) are reported for the calendar year 1971. The data for the 1972-1990 Plan are for the same categories as the 1972 Inventory but relate to the system planned to be in place by 1 Jan 1990. Operating costs are those planned for the calendar year 1989. The data for the 1972-1980 Program are also for the same categories as the 1972 Inventory but relate to the system expected to be in place by 1 Jan 1980. The following major sections of this Data Supplement generally follow the organization of Ch. 5 of the 1974 NTR: Capital Costs, Annual Operating Costs, Physical Facilities and Equipment, Demand and Supply, Performance Indicators, Social and Environmental Impacts, and Urbanized Area Populations. Each section is divided into two subsections, a first section containing summary tables for urbanized area population classes, and a second presenting the detailed figures for each urbanized area. A table of contents precedes each section.

Wells Res. Co.; Control Data Corp.  
 1976; 995p 3refs  
 Availability: GPO \$10.00, Stock No. 050-000-00114-8

HS-022 120

## TRANSPORTATION FOR ALL THE PEOPLE

The nation's airlines, railroads, intercity buses, and public transit systems are adopting new policies and acquiring new equipment to make travel for the elderly and handicapped not only possible but pleasant. Requirements for special attention to elderly and handicapped persons date back to 1970 and an amendment to the Urban Mass Transportation Act; the anti-discrimination policy was spelled out in the Rehabilitation Act of 1973, of which Section 504 says that "no otherwise qualified handicapped individual can be denied the benefits of, or excluded from participation in, any program or activity receiving federal assistance." Of the nineteen demonstration projects funded by UMTA from 1971 to 1976, directed towards the needs of all those who have difficulty traveling, fifteen (totaling \$6.3 million) were exclusively addressed to the needs of the elderly and handicapped. More than 1000 agencies na-

tionwide are involved in providing special transportation services. The May 1977 Transbus decision requires that all standard-sized buses bought with Federal funds and put out for bid after 30 Sep 1979, include features designed to accommodate handicapped and elderly persons. One form of assistance program involves demand-responsive services provided by local transit operators—subscription, charter, and door-to-door demand services. Another concept involves the use of private operators: independent taxi companies providing reduced-cost service to qualified users under subsidies paid by the program sponsors, or a coordinated program involving the social service agencies and consolidating transportation requirements and services. This consolidation of requirements may be the most cost-effective way of providing essential transportation services. A third approach is to provide total accessibility to a city's public transit system, either by acquiring new vehicles that can accommodate the handicapped, or by retrofitting existing buses to accept wheelchair passengers. Airline policy has changed to permit handicapped persons maximum access to air transportation; regulations which went into effect in 1977 prevent airlines from denying seats to handicapped persons solely because they might interfere with emergency evacuation of the airplane. Tests have shown that with proper crew training the handicapped can be evacuated successfully. A booklet titled "Access Travel: Airports" lists the special services available in 220 terminals in 27 countries. Railways and intercity bus systems are also responding to the needs of the handicapped with enlightened policies.

by John Demeter  
 Department of Transportation, Office of Public Affairs  
 Publ: Transportation USA v4 n1 p6-11 (Fall 1977)  
 1977  
 Availability: See publication

HS-022 121

## DRIVER APPROACH BEHAVIOUR AT SIX SIGNALIZED RAILROAD CROSSINGS

Approach behavior of drivers of passenger cars, vans, and half-ton and heavy trucks was unobtrusively observed at six signalized railroad crossings in Ontario, Canada, in order to provide further insights into the mechanisms that are responsible for the causation of railroad crossing accidents and to identify potential countermeasures. The variables monitored included moving speeds of vehicles at various distances away from each crossing proper, vehicle speed changes, acceleration/deceleration patterns of vehicles, driver head movements, and driver's estimated age and sex. Univariate and intercorrelational analyses of these variables, gathered when the lights were not flashing, revealed marked heterogeneity. Speed variance was found to increase as vehicles came closer to a crossing. During periods in which the lights were flashing, observation took the form of recording critical incidents, including signal violations, skids, zig-zagging between descended gates, and false alarms (no train appearing in the time interval between warning signal onset and cancellation). Critical incidents and false alarms were found to occur in significant proportions of all alarm periods. On the basis of the results, a modified warning signalling system is proposed with particular reference to the need of reducing decisional uncertainty on the

part of vehicle drivers and enhancing warning signal credibility.

by G. J. S. Wilde; L. J. Cake; M. B. McCarthy  
 Publ: Zeitschrift für Verkehrssicherheit v22 n4 p163-9 (1976)  
 1976; 18refs  
 German summary. Study sponsored by the Canadian Transport  
 Commission, Canadian National Railways and Canadian  
 Pacific Ltd.  
 Availability: See publication

HS-022 122

### THE MAINTENANCE-FREE BATTERY

The development of the maintenance-free (MF) automotive battery is discussed. The principal deficiencies of the conventional automotive battery (need for frequent topping-off, poor shelf-life and deterioration in service, and terminal corrosion) which are related in various ways to the antimony in the plate grids are overcome in the MF battery by the use of calcium-lead grids. Results of comparative tests of MF batteries, standard 4.5% antimony batteries, and low-antimony (2.5%-3%) batteries are described. Graphs are presented which show the following test results of the behavior of the three types of batteries: shelf life at 27° C; recharging at low temperature (27° C); recharging at high temperature (51.5° C); rates of deterioration at low temperature; rates of deterioration at high temperature; cycle-life test to SAE J240 showing resistance to overcharge and failure by water loss; water loss on recharge; and overcharging effects of abnormally high voltages.

by Alan Baker  
 Publ: Automotive Engineer v2 n5 p12-4 (Oct-Nov 1977)  
 1977  
 Availability: See publication

HS-022 123

### BRAKE SYSTEMS--PT. 2. HOW TO PERFORM A COMPLETE BRAKE JOB--DRUMS

In the second in a series of articles on repairing automotive brakes, step-by-step procedures for performing a brake job, with emphasis on drum brakes, are presented. Illustrations and photographs accompany the outline of steps to take for evaluating a brake system accurately and effectively and making any needed repairs. First, steps are given for checking drum and disc braking systems prior to analyzing the brakes themselves; second, steps are given for checking brake drums; and third, procedures to take after the brakes (drum or disc) have been evaluated are given.

Publ: Dealer News v40 n37 p7-17 (12-19 Dec 1977)  
 1977  
 Availability: See publication

HS-022 124

### DRIVING IN A WINTER WONDERLAND

The driver's preparations for the first snowfall of the season and precautions to take while driving once the snow has arrived are outlined. Areas to consider in preparing a car for winter driving include the following: oil change, battery, radiator, exhaust system, windshield wipers, brakes, snow tires, and chains. With respect to starting and pulling ability on glare

ice, conventional snow tires are 28% better than regular tires, and studded snow tires and reinforced tire chains respectively show 218% and 630% improvements over regular tires. Some precautions to take while driving in the snow include the following: warm up the car and scrape off all the windows, drive slowly, leave more space between your car and the one in front, slow down for turns, ease off the gas sooner for stops, and gear down and lightly pump brakes to slow car without locking the wheels. Also, be cautious when approaching a shadowy area on the road (where there might be ice patches) and slow down before reaching shadowy area and once there coast through in gear, steer left to correct for a car with the tail skidding to the left (and vice versa), and pump brakes lightly and keep the car in gear to stop skid for rear-wheel drive cars. In addition, do not brake to stop skid but speed up a little for front-wheel drive cars, and have a well-stocked trunk (e.g. first-aid kit, flashlight, flares, road maps, spare wiper blades, tools, spare parts, tow rope or chain, battery jumper cables, a small shovel, a small quantity of sand or salt, gas line antifreeze, ice scraper/snow brush).

Publ: Driver v11 n6 p8-13 (Nov 1977)  
 1977  
 Availability: See publication

HS-022 125

### METAL PRESERVATION IN VEHICLE BODIES. A REVIEW OF CURRENT PRACTICE IN THE PRETREATMENT AND PROTECTIVE COATING OF SHEET STEEL BODYWORK

A review of current practice in the pretreatment and protective coating of sheet-steel automotive bodywork is presented. The objective of a metal-finish system is to erect a barrier between the base metal or substrate and the corrosive gases, liquids, and solids. This barrier consists essentially of oils, waxes, or resins that are fixed in place by a conversion coating, which in most applications is a phosphate. Heavy phosphate coatings (iron phosphate, manganese phosphate, zinc phosphate) are used essentially as anticorrosive finishes and are not normally noted for their aesthetic appeal. Zinc phosphate coatings are by far the most widely used, and, in the context of heavy coatings, are used mainly for the "phosphate and oil" finish which is used widely on nuts and bolts. Detail parts are also given heavy zinc phosphate coatings when the subsequent paint finish is not required to have a decorative gloss. Heavy zinc phosphate coatings are sometimes used for anticuff treatment. These treatments are applied by immersion techniques in a conventional six-stage system. As important as the phosphate process is the type of sealant used, which can range from dewatering quality fluids and oils through shellac-type stains to waxes and paints. Undoubtedly, application of light zinc phosphate coating to improve paint adhesion is the most important part of the pretreatment to the car industry; application of this coating is by immersion, spray, or a combined spray/immersion process. Spray systems are preferred because they are faster. The types of cleaner and phosphate should always be chosen together as a system and the following requirements defined: material to be treated (steel, zinc, aluminum), condition of that material, time available, temperature available, type of coating required, weight of coating required, specification to be met, organic finish to be used, effluent restriction/provision, economic considerations, and control available. For a phosphate coating to be completely satisfactory, a near-perfect surface must be prepared and a cleaner should be able

to remove all dirt, oil, and temporary protectives; the cleaner should have low-foaming characteristics, coating-refining chemicals, low-scale properties, biodegradability, suitability for five-stage (one rinse) plants, and economy. The vast majority of vehicle bodies are now painted electrophoretically; the most widely used phosphate processes used in these cases are a zinc phosphate that uses nitrate and chlorate as accelerators, a zinc phosphate that contains fluoride and is accelerated by a nitrite/nitrate system, and a system containing a chlorate accelerator and separate additions of nitrite.

by P. P. Benjamin  
 Publ: Automotive Engineer v2 n5 p27-9 (Oct-Nov 1977)  
 1977  
 Availability: See publication

## HS-022 126

### SMALL CAR SUSPENSION AND STEERING

Suspension systems of various new, smaller American automobiles are described in light of today's automotive engineering challenge to maintain ride quality as larger cars are downsized and to maximize the ride quality of new smaller vehicles as they arrive in the marketplace. Ford's Fiesta, with its transverse-mounted engine, uses the MacPherson strut front suspension, with a sealed shock absorber and built-in stop bumper; its rear suspension incorporates a lightweight steel tube beam axle, coil springs and five-link axle location using trailing arms, a track bar, and telescopic shocks. GM's new "A" body cars use coil springs at all four wheels; suspension designs are basically the same as those used on full-size models, although scaled to the needs of the lighter mid-size offerings. Ford's Fairmont and the Mercury Zephyr utilize a new, improved front shock strut and large bushings at all attachment points to minimize road noise and harshness. MacPherson struts, called "Iso-struts" by Chrysler, are mounted to the front suspension of the Dodge Omni and Plymouth Horizon.

by Richard J. Fosdick  
 Publ: Automotive Industries v157 n8 p18-22 (15 Nov 1977)  
 1977  
 Availability: See publication

## HS-022 127

### ELECTRONICS '78: YEAR OF THE BREAKTHROUGH [AUTOMOTIVE COMPUTERS]

The evolution of the application of advanced electronics in the automotive industry is discussed. The first use of an electronic device as a basic subsystem of the car came in 1960 with the solid-state diode rectifiers in Chrysler's alternators. Custom integrated circuits were first applied to cars in 1972 by GM, in a voltage regulator, and in the unitized ignition built by GM's Delco-Remy Division for Pontiac. The first major electronic logic system used across the board by the industry was applied to the short-lived seatbelt interlocks. Like car radios, the first complex electronic system used in a production car, the Bendix fuel injection of 1957, used vacuum tubes. Soon thereafter its place was taken by the transistor or semiconductor device. Individual transistors were wired together with other parts to form electronic circuits. Then it was found that more than one semiconductor device, complete with linking circuits, could be formed on a single small silicon chip. In 1959 a commercially available chip contained only one component

of a circuit; today a single tiny chip can carry the many thousands of components needed by a fair-sized computer. These new LSI (large-scale integration) microprocessor chips, as used in calculators, started the automotive industry looking at applications in which their added cost could be handled. The choice of analog and digital for automotive computers was not until recently. It was simply unthinkable to fit a digital computer into a production car because it was too big, too expensive, or both. Now, with the arrival of the LSI microprocessor, that limitation is beginning to be removed and industry is rapidly and irrevocably moving toward digital computers. The beachhead for digital microprocessors in cars was established in the 1977 model year by Oldsmobile and Delco-Remy with their MISAR (Microprocessed Sensing and Automatic Regulation) spark control system used in the Toronado. In 1978, three other digital microprocessors are used to do jobs that are less vital to running of a car. One is Chrysler's solid-state search-tune radio, the second is the 1978.5 Cadillac Seville's travel guidance computer with a numerical dashboard display, and the third is the miles-to-empty system in the Lincoln Continental Mark V. To meet the tougher emissions and economy standards, the 1981 models will use LSI chips to take over control of all main engine variables (spark timing, EGR valve flow, choke control on carbureted cars, fuel preparation, and fuel/air mixture control).

by Karl E. Ludvigsen  
 Publ: Ward's Auto World v13 n11 p31-5 (Nov 1977)  
 1977  
 Availability: See publication

## HS-022 128

### DATA FOR ESTABLISHING WATER TOLERANCE AND VISCOSITY REQUIREMENTS FOR MOTOR VEHICLE BRAKE FLUIDS. PART 1 OF PHASE 1

A program was initiated to gather viscosity data on vehicles with a broad range of braking systems for eventual definition of maximum viscosity for safe vehicle operation at low temperature, and to evaluate the need for water tolerance in conventional brake systems. An evaluation was made of the vapor lock temperature of three fluids under summer ambient conditions: Delco Supreme II, RM-70 (Silicone), and GE SF700 (Silicone). Five test sequences were used for each of the three, first, with humidified fluid in the system, then with humidified fluid in the system plus 0.5% water added to the master cylinder, with 2.0% water added, with 0.5% water added to the wheel cylinders/calipers, and with 2.0% water added to the wheel cylinders/calipers. Additionally, a test procedure for determination of in-vehicle brake fluid vapor lock temperature was evolved. In each instance vapor lock occurred only in the rear brakes, while front brakes remained operative. The addition of large amounts of water at the master cylinder had no effect under the conditions of the test, regardless of fluid type. The six or seven runs on each fluid may therefore be considered to be repetitive and used as a measure of the precision of the vapor lock temperatures determined. It was demonstrated that gross amounts of water added to the brake system at the wheel cylinders produced vapor lock at approximately 212° F (100° C) regardless of the type of fluid used, when the vehicle was subjected to the vapor lock test sequence. Two tables and two graphs present a summary of test results; appendices include information on brake system fluid volumes and water volumes; on the bulk humidification procedure; the Automatic Res. Associates (ARA) chemical lab humidification data; the preparation of vehicles



for testing; photographs and diagrams; and raw data from the test runs.

by J. G. Brown  
Automotive Res. Associates, Inc., 5404 Bandera Rd., San Antonio, Tex. 78238  
1977; 119p  
Project monitored by SAE Res. Proj. Com. R-18.  
Availability: SAE

HS-022 129

# **ROLLING RESISTANCE OF TRUCK TIRES AS MEASURED UNDER EQUILIBRIUM AND TRANSIENT CONDITIONS ON CALSPAN'S TIRE RESEARCH FACILITY. FINAL REPORT**

Results are presented from a test program to measure the rolling resistance characteristics of selected 11 x 22.5 truck tires. Problems in measuring rolling resistance experiments are minimized by a flat rigid surface and precise control and balance systems that can measure all variables of interest with high accuracy. A photograph of the facility and a detailed description are appended. Test data from the study provide a data base which contributes to the understanding of truck tire rolling resistance and its relationship to operating variables. The influences of tire wear, speed, load, torque, slip angle, inflation pressure, temperature, carcass construction, tread pattern, and distance traveled on rolling resistance were investigated. A short description of the test program and a brief summary of the results are included. Conclusions are that the rolling resistance of truck tires decreases with wear; the amount of decrease is about twice as much for bias tires as for radials. Rolling resistance values of a tire measured on a 1.708 m (67.23 inch) diameter drum are greater than those measured on a flat road under the same loads; if equivalent drum loads are used, the measured values are greater than they are for flat road loads. Rolling resistance of bias ply tires is greater than that of radial-ply tires; in general, the rolling resistance coefficient is 50% greater for bias tires than it is for radials. Rolling resistance coefficients of bias ply tires increase with load whereas for radial tires they generally decrease. Tire replication of a three-tire sample showed variations in rolling resistance of up to 13% for radial tires and up to 8% for bias tires. This variation reduced to 6% for the radial tires if the set of data that was based upon an average of the low and high pressure tests were ignored. The rolling resistance of truck tires decreases with increasing inflation pressure, and increases with increasing speed. Minimum rolling resistance does not necessarily occur at zero wheel torque or at zero slip angle. Tire rolling resistance is generally inversely proportional to contained air temperature. Tire warmup characteristics exhibit an exponential behavior.

by I. Gusakov; D. J. Schuring; D. Kunkel  
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221  
Contract DOT-OS-60156  
Rept. No. ZM-5947-T; DOT-TST-78-1; 1977; 212p 8refs  
Availability: NTIS

HS-022 130

# **GLOSSARY OF AUTOMOTIVE TERMINOLOGY. FRENCH-ENGLISH, ENGLISH-FRENCH (GLOSSAIRE DE LA TERMINOLOGIE**

## **AUTOMOBILE. FRANCAIS-ANGLAIS, ANGLAIS-FRANCAIS)**

The glossary, originally developed as an aid to Chrysler employees working with both French and English automotive terminology, contains approximately 17,000 entries. Accents and annotations for part of speech, gender, and number appear in the French half. The annotations have been applied to all single-word entries, and to the first word (key word) of some multiword entries.

Chrysler Corp.  
Rept. No. SAE-SP-423; 1977; 233p  
Availability: SAE

HS-022 131

## **BIBLIOGRAPHY ON ELECTRIC VEHICLES. 1967-1976**

A bibliography on electric vehicles and their power sources covering the years 1967 to 1976 cites books, reports, symposia proceedings, and periodical literature. Most items should be available through libraries or, in some cases, the publishers. The scope includes all self-propelled vehicles using electric power sources; main emphasis is on road vehicles, with some off-road vehicles included. The arrangement is topical, each citation being placed under the topic most relevant to its content. "See also" references are included when necessary. An author index is included.

by Emily R. Mobley, comp.  
General Motors Res. Labs., Library, Warren, Mich. 48090  
Rept. No. SAE-77-401; GMR-2424; 1977; 210p 1ref  
Availability: Corporate author

HS-022 132

## **VEHICLE MAINTENANCE REPORTING STANDARDS. 1. REPORT OF STUDY**

Recommendations for vehicle maintenance reporting standards are developed by identifying the data required for various levels of motor carrier management, by formulating definitions of terms and data classification to assure adequate information in recorded data, by assigning data codes for these classifications, and by developing work order forms. Evaluation of current reporting systems revealed that the reliability of data was not verifiable due to wide differences in depth, uniformity, and understanding in reporting techniques used by different fleets. Recommended as essential for a standard management information system are identification and classification of cargo-carrying motor vehicles and their components, the operating conditions affecting maintenance requirements, and conditions and performance of maintenance. Recommended standard codes for recording these data include codes for activity (vehicle work assignment), reason for repair, work accomplished, repair class (timing of repairs), repair site, part failure, vehicle type, vehicle component, and indirect labor. Recommended standard forms for recording data include vehicle master record and vehicle control card for power unit and for trailers, containers and converter dollies, driver's vehicle condition report, repair order, repair order log, and time card for direct and indirect labor. Standard procedures to facilitate data processing for management information include maintenance recordkeeping procedures, descriptions, and flow charts, and data processing system flow charts. Recommended

report formats for presenting information to management are vehicle inventories, data reliability control, vehicle and fleet maintenance analyses using standard codes, indirect costs control, and maintenance and running costs.

Paquette and Associates

1970; 42p 8cdfs

An American Trucking Associations, Inc. (ATA) Foundation Proj. of Union 76 Div., Union Oil Co. of California. See also HS-022 133--HS-022 135.

Availability: ATA, Management Systems Dept., 1616 P St., N.W., Washington, D.C. 20036 \$15 for complete report

HS-022 133

## VEHICLE MAINTENANCE REPORTING STANDARDS. 2. FORMS AND PROCEDURES

Detailed procedures are provided for using recommended reporting forms, such as the vehicle master record, vehicle control card, driver's vehicle condition report, repair order, repair order log, and time cards for direct and indirect labor. These procedures describe the data recording functions of maintenance facility personnel and are oriented to automated data processing, although the same functions can be manually performed with minor changes. Procedural flow charts and sample forms are included.

Paquette and Associates

1970; 43p

An American Trucking Associations, Inc. (ATA) Foundation Proj. of Union 76 Div., Union Oil Co. of California. See also HS-022 132, HS-022 134, and HS-022 135.

Availability: ATA, Management Systems Div., 1616 P St., N.W., Washington, D.C. 20036 \$15 for complete report

HS-022 134

## VEHICLE MAINTENANCE REPORTING STANDARDS. 3. MANAGEMENT REPORTS

The management information reports of the activities of the maintenance facility may be grouped by subject as follows: vehicle inventory, data reliability, activities trend, vehicle out-of-service trend, equipment utilization, overhead, work accomplished on vehicle components, reasons for repairs, indirect labor applications, and exceptional activities. Reports of the distribution of maintenance effort to individual vehicles may be grouped as follows: total maintenance and running costs, maintenance by component, fuel and oil consumption, warranty claims, accident reports, and road calls. A descriptive analysis of each report and its purpose is provided.

Paquette and Associates

1970; 53p

An American Trucking Associations, Inc. (ATA) Foundation Proj. of Union 76 Div., Union Oil Co. of California. See also HS-022 132, HS-022 133, and HS-022 135.

Availability: ATA, Management Systems Dept., 1616 P St., N.W., Washington, D.C. 20036 \$15 for complete report

HS-022 135

## VEHICLE MAINTENANCE REPORTING STANDARDS. 4. DATA CODES AND GLOSSARY

Standard maintenance data codes should be universal, dynamic (capable of expansion), acceptable to users, comprehensive,

definable, and practical. The codes should be structured for operation within either a manual recordkeeping system or by a system oriented toward automated or electronic data processing. Four systems of standard data codes are presented: equipment type, repair order, maintenance facility information, and vehicle component. The equipment type code is composed of subcodes for classifying basic vehicle specifications. Repair order codes are designed to facilitate the identification and classification of maintenance data at the source. These data include reason for repair, work accomplished, repair class, repair site, and part failure. The maintenance facility information code includes the reporting of indirect labor applications. The vehicle component code was developed to allow fleet operators to gather and record information by major groups or classifications only, or to record detailed information on individual parts. Complete lists of codes by types are provided, including labeled drawings for component identification.

Paquette and Associates

1970; 200p

An American Trucking Associations, Inc. (ATA) Foundation Proj. of Union 76 Div., Union Oil Co. of California. See also HS-022 132--HS-022 134.

Availability: ATA, Management Systems Dept., 1616 P St., N.W., Washington, D.C. 20036 \$15 for complete report

HS-022 136

## TRANSPORTATION AND TRAFFIC ENGINEERING HANDBOOK

Twenty-three reports on transportation and traffic engineering are concerned with vehicle, highway, and travel facts, such as characteristics of vehicle operation, of drivers and pedestrians, and of general traffic, urban travel, and mass transportation. Other topics include traffic flow theory, highway capacity, traffic accident analysis, and traffic studies. Computer applications, urban, statewide, and regional transportation planning, and geometric design of highways are also included. Parking, loading, and terminal facilities are discussed, as are traffic signs and markings, traffic signals, speed regulations and other operational controls, and traffic surveillance and control. Lighting of traffic facilities, environmental considerations in traffic engineering, traffic engineering administration, and application of systems concepts are also discussed.

by John E. Baerwald, ed.; Matthew J. Huber, ed.; Louis E. Keefer, ed.

Institute of Transportation Engineers

1976; 1090p refs

A complete revision of the Traffic Engineering Handbook, 3rd Ed., 1965. Includes HS-022 137--HS-022 148.

Availability: Prentice-Hall, Inc., Englewood Cliffs, N.J.

HS-022 137

## VEHICLE, HIGHWAY AND TRAVEL FACTS

The principal trends in vehicle and highway use in the U.S. are summarized, with related factors such as population, motor vehicles in use, and mode of domestic passenger travel and of domestic intercity freight movement. Road and street mileage and annual highway finances in the U.S. are compared to those of France, Germany, Great Britain, and Sweden. Canadian statistics are provided for per capita highway expen-

diture. Sources of information are given to permit a periodic update.

by Woodrow W. Rankin  
Highway Users Federation, 1776 Massachusetts Ave., N.W.,  
Washington, D.C. 20036  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 1 p1-15  
1976; 5ref  
Availability: In HS-022 136

HS-022 138

## VEHICLE OPERATING CHARACTERISTICS

The physical characteristics of passenger cars and trucks are considered as they relate to traffic engineering. Resistance to rolling, air, grade, curve, and inertia forces must be overcome by vehicles in motion, as well as engine compression forces during deceleration in gear. Weight/horsepower ratios are useful for determining overall performance characteristics, especially for comparing the performance of different vehicle types. Information on maximum acceleration performance is needed for evaluation of minimum sight distance requirements for passing and for determination of minimum lengths of acceleration lanes at stop and yield signs and in interchanges. Normal acceleration rates are a factor in designing cycle length of traffic signals, in computing fuel economy and travel time values, and in estimating how normal traffic movement is resumed after interruption. Deceleration performance is measured with and without brakes, and maximum and normal deceleration rates are determined. Maximum deceleration rates are used to estimate minimum stopping distance in emergencies; normal rates provide the basis for estimating reasonable time and road lengths for stops at signs and signals. Traffic engineers need to know how vehicle operating costs are related to road geometry, surface conditions, traffic flows, and speed change requirements. These costs include fuel consumption, tire wear, maintenance cost, oil consumption, and depreciation, as well as congestion costs due to speed changes and stopped delays. Information on vehicle dimensions is needed for planning road and street geometrics and parking lot layouts.

by Paul J. Claffey  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 2 p16-37  
1976; 13refs  
Availability: In HS-022 136

HS-022 139

## DRIVER AND PEDESTRIAN CHARACTERISTICS

Driver and pedestrian characteristics are described, including behavior patterns and accident involvement factors. Bicyclists and bicycle usage are discussed, as are features of vehicle design such as lighting. Measurable variables such as age and sex of drivers are important in driver control efforts. It is concluded that sex is not an accident factor but that both young and old drivers are overrepresented in accident statistics. This justifies differential licensing. Research results suggest that marital status, education, and annual mileage are accident factors but do not justify differential licensing. Chronic medical conditions and impaired hearing or vision appear to be factors but further research is needed. Elements in the driving task are expectation and reaction time, shared tasks (division of attention), willful vs. inadvertent error, and visual attention. Al-

cohol, drugs, age, mental stress, and fatigue affect driver performance. At low blood alcohol levels, alcohol's effects do not become apparent until a secondary visual or auditory task is imposed upon the driver. Some drugs in combination with alcohol produce an effect greater than the sum of their individual effects. Age was found to affect tasks requiring division of attention. Falling asleep at the wheel was found to cause from 30% to 50% of highway fatalities. Alcohol, tranquilizers, antihistamines, barbiturates, and other substances promote drowsiness. Increasing the driver's blood sugar level tends to prevent drowsiness. Certain drivers are prone to fall asleep at the wheel when not otherwise fatigued. Children and the elderly have the highest pedestrian fatality rate, and urban areas produce the most pedestrian accidents. Observation of pedestrian regulations appears to depend on the presence of police. Wearing light colored clothing is apparently a factor in preventing nighttime pedestrian accidents. Alcohol was found to be a factor in pedestrian fatalities. Types of pedestrian injuries seem to relate to the profile of the vehicle and the size of the pedestrian. Most pedestrians struck by trucks are run over by the wheels, whereas an adult is tossed by a passenger car. Children are more liable to be run over or propelled horizontally. Countermeasures suggested to prevent pedestrian accidents include street parking redeployment, meter post barriers, and signal retiming or modification.

by Slade Hulbert  
M. B. Associates, P.O. Box 196, San Ramon, Calif. 94583  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 3 p38-72  
1976; Refs  
Availability: In HS-022 136

HS-022 140

## GENERAL TRAFFIC CHARACTERISTICS

The general traffic characteristics important to the planning, design, and operation of a transportation system are described: volume, speed, headway, parking, and accident patterns and trends. Traffic movement can be quantitatively described by the flow rate (volume of vehicles), the speed (time rate of movement), and the density (concentration of vehicles). Traffic volume characteristics include such spatial distribution variations as rural/urban distributions, distribution by direction, and lane distribution. Temporal variations include the season, the day of the week, hourly patterns, and peak intervals within the hour. Traffic composition is measured by percentage of trucks and buses at a given location. Speed characteristics are influenced by the driver, vehicle type, roadway, traffic, and environment. Roadway elements affecting speed include functional classification, curvature, gradient, length of grade, number of lanes, and surface type. Speed patterns are also affected by geographical location, sight distance, lane positions, lateral clearance, and frequency of intersections. Speed is also related to traffic volume and density, passing opportunities, and access control. Environmental variables of time and weather affect speed, due to impaired visibility and road surface conditions. Access control is an important safety advantage. Among the roadway conditions affecting accident frequency are alignment, cross section (lane width), intersections, interchanges, driveways, and railroad crossings. Parking, one-way streets, and illumination are also factors in accident frequency. Parking characteristics include supply and demand, usage of curbside parking, duration, turnover, and walking distance to destination. Parking accumula-

tion is charted for various city sizes and for industrial plants, commercial centers, and residential areas.

by Joseph C. Oppenlander  
University of Vermont, Dept. of Civil Engineering, Burlington, Vt. 05401  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 4 p73-137  
1976; Refs  
Availability: In HS-022 136

HS-022 141

## URBAN TRAVEL CHARACTERISTICS

Information is summarized on generation, purpose, and length of trips, and on travel modes, as well as on travel characteristics of central business districts and other major traffic generators. Influences of population, density, land use, income, car ownership, and age upon trip generation are demonstrated. Trip generation analysis generally includes trip production (home-centered) and trip attraction (non-home-centered). There are hourly variations of travel on a typical weekday according to travel mode, city size, vehicle class, and the number of cars in motion and at rest. Person-miles and vehicle-miles of travel and urban trip lengths become important planning parameters. Motor truck travel represents about 15% of the total daily urban vehicle trips, with truck trips per capita decreasing with increasing city size. It is significant that about 60% of all truck deliveries are made at the front entrance curb, last from about 20 minutes to an hour, and up to 75% of the trucks are parked illegally. Downtown transportation planning should be based on existing and future land uses, on the travel demands and the linkage requirements generated thereby, on adaptations of the environment to optimize these requirements, and on policies and technologies necessary to achieve these objectives.

by Herbert S. Levinson  
Wilbur Smith and Associates, New Haven, Conn. 06500  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 5 p138-206  
1976; 37refs  
Availability: In HS-022 136

HS-022 142

## TRAFFIC ACCIDENT ANALYSIS

Study in detail of individual accidents and study of groups of accidents at the same location or at similar locations serve different purposes in traffic accident analysis. Individual accident study can be conducted at five levels: accident reporting, supplementary data collection, technical data preparation, professional reconstruction, and cause analysis. Of these, the first two are generally conducted by police; engineers may participate in the others. Accident reconstruction involves inferences about speeds, position on the road, observation or comprehension of traffic control devices, and evasive tactics. Interpretation of tiremarks is important in accident reconstruction, as are certain aspects of vehicle damage. Dynamics concepts are often used, such as bodies in motion through space, dissipation of energy by friction, and centrifugal force. Combined speed estimates and speed changes in collision must be estimated. In analyzing accidents at specific locations, decisions are involved concerning locations to study, possibilities of improvement, cost/benefits of the improvement, selection of locations to improve, and evaluation of the improvement

when accomplished. Problems include deficiency in identifying locations on accident reports, incomplete or haphazard reporting, and the tendency of reporting agencies not to report minor accidents. Accident data may be weighed by severity of injury, by accident cost, or by number of traffic units involved. Roads may be classified for accident studies as junctions or sections and by character of service. Locations can be ranked according to accident experience by number of accidents or by the accident rate. Among the devices for determining possible remedies at a high accident risk site are collision diagrams, condition diagrams, traffic counts, and instruments for reducing accident severity. Accident-reducing remedies at specific locations are designed either to prevent specific kinds of accidents or to prevent accidents in general. Methods of estimating results of accident-reducing improvements are discussed: counting methods, time period estimates, estimates without location studies, and dollar value of accidents prevented. Methods of estimating the cost/benefits of highway improvements are described, as are methods of evaluating the results of improvement.

by J. Stannard Baker  
Northwestern Univ., Traffic Inst., Evanston, Ill. 60204  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 9 p377-403  
1976; 13refs  
Availability: In HS-022 136

HS-022 143

## TRAFFIC STUDIES

Studies made by the traffic engineer can be classified as administrative studies (use of current data on file), inventories of static features, and studies of the dynamic and variable characteristics of traffic. The last of these concerns the operational characteristics of the traffic stream: drivers, pedestrians, and vehicles. For planning purposes, basic data are needed on purpose of trip, mode of travel, automobile ownership, and social/economic characteristics of road users. Land-use inventories and plans, motor vehicle ownership trends and use, and employment data and forecasts are among the prepared data used by the traffic engineer. Vehicle volume studies, stratified by time of day, direction of travel, and type of vehicle, can be conducted by spot counts, areawide studies (urban or rural), cordon counts, or screen line counts. Equipment used may include a sensing device or detector, a counter, and multi-pen recorders. Manual volume counts are used when automatic devices are ineffective or too costly. Spot and route speed studies are carried out to obtain information on speeds of traffic streams. Spot studies are accomplished by stopwatch or by electronic means. Travel time and delay studies utilize observation by test vehicles. Other traffic stream studies involve measurement of density, gaps, and vehicle spacing. Intersection studies include those of capacity at signalized intersections, of queues, and of intersection delays. When two traffic streams conflict, gap acceptance studies are made. Criteria for school crossing protection are evolved from studies of hazards based on appraisal of street widths, vehicle speeds and volume, pedestrian volume, and gaps in the traffic stream. Studies are also made of traffic conflicts and intersection speed. Among the studies on driver and vehicular performance are those on acceleration and deceleration, travel paths, sight distance, and safe speed. Public transit studies provide information on ridership and user needs. Law observance studies include speed limit, traffic signal, traffic regulation, and parking observance. Parking studies include information on parking supply and demand, space occupancy,

## HS-022 144

duration and turnover, and truck loading zones. Accident studies involve collection of data, filing procedures, and traffic engineering studies, which include accident analyses, spot maps, high accident frequency location lists, and collision, strip, and condition diagrams. Environmental studies on noise, air, and water pollution may have impact on the work of the traffic engineer.

by Donald E. Cleveland  
University of Michigan, 1201 E. Engineering Bldg., Ann Arbor, Mich. 48109  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 10 p404-70  
1976; Refs  
Availability: In HS-022 136

## HS-022 144

**TRAFFIC SIGNS AND MARKINGS**

All traffic signs and markings in the U.S. should follow the accepted standards of the "Manual on Uniform Traffic Control Devices for Streets and Highways" (Uniform Manual). Each device should fulfill a need, command attention, convey a clear, simple meaning, command user respect, and give adequate time for response. Traffic signs may be functionally classed as regulatory, warning, or informational/guiding. Some signs convey messages for use at certain times of day, or under certain traffic conditions. Standard shapes, colors, and sizes aid in providing attention value, legibility, and recognition. Letter sizes and spacing are designed for legibility at normal traffic speeds, aided by reflectorization and illumination. Sign location, type of mounting, and supports are designed for ease of identification, reduced glare, minimum maintenance, and driver safety (breakaway construction). Warrants provide a guide to sound sign application and serve to prevent the overuse of regulatory signs. An improper installation, failure to replace or repair a damaged or missing control device, or failure to conform to Uniform Manual standards may lead to liability of a government agency or responsible official. Materials in general use for traffic signs include outdoor plywood, aluminum and steel sheeting, fiberglass, and plastic. Paint, adhesive-coated plastic film, porcelain, reflective sheeting, or bead coatings with a binder are used for sign faces. Inventory and adequate maintenance are necessary. Traffic markers include all traffic lines (longitudinal and transverse), symbols, words, object markers, delineators, cones, or other devices. Special markings include lane reduction transitions, obstruction markings, reversible lane markings, two-way left turn lanes, and channelization. Traffic lanes may be painted or made of thermoplastic or prefabricated tape. Other types include raised markers, reflectorized striping powder, and glass beads. Barricades, traffic cones, barricade warning lights, rumble strips, and mileposts are also used to guide traffic.

by J. Robert Doughty  
Pennsylvania Dept. of Highways, Transportation Safety Bldg., Harrisburg, Pa. 17120  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 16 p731-81  
1976; Refs  
Availability: In HS-022 136

## HS-022 145

**TRAFFIC SIGNALS**

Traffic signals must always be easily recognized and their meaning understood; they should be uniform and installed under unimpeachable authority, and compliance should be legally enforceable. The need for a traffic control signal at any location should be evaluated in relation to the following warrants: minimum vehicle or pedestrian volume, interruption of continuous traffic, school crossings, progressive movement, accident experience, systems, or a combination of warrants. Factors such as roadway features, age of pedestrians, and effect of adjacent signals are also important in determining the need for a traffic signal. Pretimed, traffic actuated, semiactuated, fully actuated, or volume density controllers are the main types of signals in use. Computers are available which act as master controllers over one or more signals. Among the commonly used ancillary equipment items are flashers, relays, preemptors, time switches, and manual control panels. Variations in the signal faces include arrow lenses, optically directed lenses, and pedestrian signals. Traffic-actuated controllers require detectors, the simplest form being the pedestrian push button. Four main categories of detectors are over-pavement, on-pavement, in-pavement, and under-pavement (least susceptible to damage). They respond to passage of a vehicle, limited presence of a stationary vehicle, continuous presence, dynamic presence (vehicle above a minimum speed), and to speed (by combination of two passage detectors). Twenty methods of vehicle detection are listed, some experimental. Traffic signals can be interconnected by cable, radio, or leased telephone line. Procedures for timing traffic signals have recently been reduced to mathematical models suitable for computer solution, such as SIGART, developed for the Toronto traffic control system. When there is an intersection of two or more timed routes, either an open or a closed signal network results. Innovations in signals include split-phase signalling (advanced or extended green interval), time-elapsed signals, and green wave (pacer) systems using speed indications. In many cases there is an increase in accidents after installation of a traffic signal; traffic surveys before installation and care in design and installation are needed.

by Samuel Cass  
Municipality of Metropolitan Toronto, 30th Floor, Simpson Tower, 401 Bay St., Toronto 100, Ontario M5H 2Y4, Canada  
Publ: HS-022 136, "Transportation and Traffic Engineering Handbook," Englewood Cliffs, N.J., 1976 Ch 17 p782-852  
1976; refs  
Availability: In HS-022 136

## HS-022 146

**SPEED REGULATIONS AND OTHER OPERATIONAL CONTROLS**

Among the factors affecting speed regulations are public attitude, accident frequency, and severity vs. speed. A Bureau of Public Roads study indicated that the chance of accident involvement increases with the deviation from average traffic speed, accident-involvement rates being highest at very low speeds. The two basic speed controls are regulatory and advisory (nonenforceable). Regulatory controls include statewide regulations and zoned speed regulations; they should be based on engineering and traffic data to justify their enactment, such as prevailing vehicle speeds, measurable physical features, accident experience, and traffic characteristics and control. Advisory speed limits may be determined by trial speed runs with

a test vehicle or by office calculation. Special problems in establishing speed limits include night vs. day limits, differential limits by type of vehicle, limits for adverse weather conditions, variable limits by freeway lanes, and school zones. Driver reaction to posted speed limits is influenced by the reasonableness of the limit, the degree of local enforcement, and the tolerance of enforcement agencies. One-way streets, operated as full-time or part-time single direction, or in reverse direction at certain hours, can increase street capacity and traffic safety. Disadvantages of one-way streets are increased distance to a vehicle's destination, confusion by drivers unfamiliar with the street pattern, and impeding of emergency vehicle routes. A reversible lane system is an efficient method of increasing rush-hour capacity of existing streets, although capacity may be reduced for minor flows and there may be operational problems at the terminals. The system may also require increased driver concentration. Various kinds of segregation include special routings for trucks, special lanes reserved for transit vehicles, and special routing for events attracting large volumes of traffic. Preplanning such as snow emergency routes is recommended for traffic control in weather emergencies. Turn regulations avoid vehicle-to-vehicle and vehicle-to-pedestrian conflicts. Multiphase signal timing and continuous left turn lanes are two methods of turn control. Physical barriers or grade separation structures include median barriers, curbs, glare screens, shoulder-edge barriers, and impact-attenuating devices. Pedestrian control can be accomplished by physical barriers such as fences or chains, or by grade separations. Rumble strips are used to warn drivers that a situation approaches which requires unusual alertness. The strips are not recommended for speed control.

by Robert E. Titus  
West Virginia Dept. of Highways, Room 1040, 1900  
Washington St., E., Charleston, W. Va. 25305  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 18 p853-89  
1976; Refs  
Availability: In HS-022 136

HS-022 147

## TRAFFIC SURVEILLANCE AND CONTROL

Traffic surveillance is accomplished by using traffic sensors, a transmission network, and a central digital computer with peripheral devices and consoles which function to collect traffic data, to indicate prevailing traffic conditions, and to anticipate developing congestion problems. Visual detection techniques include photographic surveillance, human observers, and closed circuit television (CCTV). Nonvisual techniques include induction loop detectors for counting adjacent lanes of traffic, supplemented by overhead ultrasonic detectors and magnetometers in the pavement. Incident detection is an important aspect of traffic surveillance, as is performance measurement of various control techniques. Audio communications assist authorities to communicate with a disabled motorist and to provide appropriate aid response. Existing motorist aid systems (MAS) are listed. Visual communication for driver information can be based on changeable message signs for route guidance, incident and congestion warnings, lane use designation, weather conditions, and general traffic information. Ramp control is accomplished by ramp closure, ramp metering, and merge control (gap acceptance). CCTV can act as an adjunct to certain control actions, as an identification device for traffic incidents, and as a supplement to a motorist aid telephone system in identifying a driver's need for assistance. An adjunct to ramp control is improvement of

freeway capacity by making changes in geometrics. When geometric design is the major cause of traffic bottlenecks, significant accident reduction is achieved by surveillance and control. When traffic demand is the major problem, there is less likelihood of accident reduction. The effectiveness of traffic surveillance and control can be measured by such factors as total travel served, total travel time expended, accident and hazard rates, and incident delays. Traffic growth can also be monitored by traffic control. The costs of sensors, communications, and computational equipment are briefly discussed, as well as facilities and operational costs.

by Patrick J. Athol  
University of Pittsburgh, Pittsburgh, Pa.  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 19 p890-911  
1976; 10refs  
Availability: In HS-022 136

HS-022 148

## LIGHTING OF TRAFFIC FACILITIES

Lighting can significantly improve the efficiency of traffic operation, providing increased safety as a byproduct. Lighting improves contrast and discernment by surface detail, but identification of most objects depends on static and dynamic visual acuity. Glare, physiological and psychological, is detrimental to driver performance. Visual information needs of drivers may be classified as for positional performance, situational performance, or navigational performance. Fixed lighting can improve contrast by lighting the roadway surface. The need for lighting can depend on the roadway's primary function, the area classification (commercial, intermediate, or residential), night traffic volume, and speeds, as well as on traffic maneuvers and access characteristics, pedestrian traffic, and number of accidents. Various types of light sources are compared as to efficiency and lamp life: mercury vapor, metal halide, high and low pressure sodium, and fluorescent. Criteria for luminaire design and placement are discussed, the principal design criteria being average intensity and uniformity of illumination. The design process includes evaluating lighting needs, selecting appropriate illumination criteria and proper equipment, and establishing correct lighting placement. Some design features are transitional lighting, safety features (breakaway bases), partial lighting (intersections only), and high-mast lighting. Tunnels and underpasses pose special lighting problems. Operation and maintenance factors in lighting design include electric power considerations, lamp ballasts, and higher mounting heights. Among the benefits of highway lighting are reduced accident rates on both high speed and local roadways, and crime reduction and improved business in urban areas. Cost considerations are briefly outlined.

by Neilon J. Rowan; Ned E. Walton  
Texas A and M Univ., College Station, Tex. 77843  
Publ: HS-022 136, "Transportation and Traffic Engineering  
Handbook," Englewood Cliffs, N.J., 1976 Ch 20 p912-43  
1976; Refs  
Availability: In HS-022 136

HS-022 149

## LIGHTING, VISIBILITY, AND RAILROAD-HIGHWAY GRADE CROSSINGS

Ten papers concern such aspects of railroad/highway grade crossings as warning system technology, traffic control, ac-

cident prediction equations, and a computer program for road-way lighting. Other topics include visual performance of drivers during rainfall, disability glare, evaluation of nighttime sign surrounds, and poor visibility under low-beam headlights. Use of encapsulated-lens reflective sheeting on overhead highway signs is discussed, as is the improved illumination of the I-76 overpass in Philadelphia, Pa.

by Frances R. Zwanig, ed.

National Acad. of Sciences, Transportation Res. Board, 2101 Constitution Ave., N.W., Washington, D.C.

Rept. No. TRR-628; 1977; 62p refs

Includes HS-022 150-HS-022 157. Sponsored by Group 3,

Operation and Maintenance of Transportation Facilities.

Availability: Corporate author \$2.40

HS-022 150

### GRADE-CROSSING WARNING-SYSTEM TECHNOLOGY

The objectives, content, and results of a large number of research projects sponsored by the Federal Railroad Administration are reviewed and related to possible improvement concepts associated with motorist-warning systems at railroad/highway grade crossings. Subjects considered include the following: modularization concepts and alternative components in warning-control logic systems; cost reduction in automatic gate equipment; flashing lights using xenon flashlamp technology; functional requirements and relevant equipment for lightning protection and standby power; and studies of alternative or novel warning system concepts. Items which would lead to significant, if modest, cost savings include improvements in gate arms and drive mechanisms and in control-system modularization, possibly using logic elements other than gravity relays. Xenon flashlamps (strobe lights) at grade crossings would be more conspicuous and would eliminate the need for expensive cantilever mounting structures. Also considered are automatic gates, radar train detection, track radar, locomotive-mounted transmitters, and train indicators. The goal of achieving significant cost reductions and increased safety effectiveness at railroad/highway grade crossings purely through technical innovation appears to be attainable only to a limited degree and is technically very challenging.

by John B. Hopkins

Transportation Systems Center, Cambridge, Mass.

Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p1-6

1977; 15refs

Sponsored by Com. on Railroad-Hwy. Grade Crossings.

Availability: In HS-022 149

HS-022 151

### TRAFFIC-CONTROL MEASURES AT HIGHWAY-RAILWAY GRADE CROSSINGS WITH PROVISIONS FOR LIGHT RAIL TRANSIT

A light rail transit line is under construction in Edmonton, Alberta, Canada which will cause frequent disturbances to the road traffic that operates at saturation during peak hours. The surface portion of the line is along the railway right-of-way, and as a result the operation of its eight grade crossings is regulated by railway authorities. The goals in designing its grade crossings are to minimize capacity losses to the road network, and to minimize delays and the number of forced

stops of both road traffic and trains. The basic principles of design include the following: coordination of adjacent signalized intersections in such a way that the impact of the crossing closure is minimized and the system recovers shortly after the closure; integration of light rail transit scheduling and control with traffic controls (restricting closures to a minimum); and use of special safety features such as warning of traffic backups ahead and special phase sequencing to maintain traffic flow in the directions unaffected by the crossing closure.

by J. Schnablegger; S. Teply

Edmonton Transportation Planning Branch, Canada; University of Alberta, Dept. of Civil Engineering, Canada Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p6-11

1977; 9refs

Sponsored by Com. on Railroad-Hwy. Grade Crossings.

Availability: In HS-022 149

HS-022 152

### DEVELOPMENT AND APPLICATION OF A RAILROAD-HIGHWAY ACCIDENT-PREDICTION EQUATION

Development of an accident-prediction equation for train/vehicle collisions at railroad/highway grade crossings that can be used as the basis for the establishment of a priority order for signal improvements was based on study of 1140 grade crossings on Florida state roads. Most of the quantitative and physical factors in the grade crossing environment were included. The model was developed by use of a stepwise regression analysis and three unconventional statistical techniques. The first technique was based on analysis of the plots of the residuals, which indicated that a transformation was required. With the transformation of the dependent variable to a logarithmic form, the plot of the residuals was reasonably symmetric. The second technique was based on the observed interaction between the independent variables, which resulted in the use of dummy variables, particularly those for active (warning devices) times daily traffic and number of trains. The third was a bias in the accident prediction that was introduced by the use of logarithms and eliminated by use of a nonlinear least squares adjustment. The model had a multiple correlation of 0.43. The independent variables in the model were the traffic, number of trains, vehicle speeds, train speeds, number of lanes, and presence of warning devices. Its accuracy was demonstrated by comparing actual with predicted accidents. The actual number of train/vehicle accidents in 1975 was 70% of the number predicted by the model; in 1975, the total number of accidents remained unchanged from that in 1974, but the number of train/vehicle accidents decreased 22%.

by Robert A. Lavette

Florida Dept. of Transportation

Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p12-9

1977; 8refs

Sponsored by Com. on Railroad-Hwy. Grade Crossings.

Availability: In HS-022 149

HS-022 153

# **VISUAL PERFORMANCE OF DRIVERS DURING RAINFALL**

The degradation of drivers' static visual acuity in terms of visual angle, detection probability, and legibility as a function of rain intensity was determined by experiments that used a rainfall simulator which produced artificial rain. The tests also assessed improvement to visibility by windshield wipers at various cyclic rates. All testing was done on overcast days, with wind velocity less than 5 mph. Subjects were tested from a 1975 model automobile. Water on the windshield was shown to be the primary factor accounting for reduced visual performance. Visual degradation in the daytime with windshield wipers in operation appears to be a linear function of the rain rate with normal drop sizes. During nighttime conditions, drop size is a significant factor in reducing visual performance; smaller drops are a more serious problem than is the rain rate. Wiper speeds above 50 cpm do not improve visual performance. Without windshield wipers, visual performance is reduced to levels that are unacceptable for driving (equivalent to visual acuity greater than 20/200) at rain rates greater than 1 inch per hour. The effective rain rate can be determined from the vehicle velocity, the terminal velocity of the drop, the rake angle of the windshield, and the actual rain rate.

by Ron S. Morris; John M. Mounce; Joe W. Button; Ned E. Walton  
Texas A and M Univ., Texas Transportation Inst.  
Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p19-25  
1977; 4refs  
Sponsored by Com. on Visibility. Research sponsored by National Hwy. Traffic Safety Administration.  
Availability: In HS-022 149

HS-022 154

# **COMPUTER PROGRAM FOR ROADWAY LIGHTING**

A model of a computer program for the design and evaluation of fixed highway lighting combines the design tasks of luminaire selection, performance evaluation, and economic comparison of various alternative systems. It calculates the illuminance, luminance, and disability veiling brightness in each lane at specified grid points on the road surface for regular, straight rows of luminaires, for a straight highway up to six lanes wide. Isoilluminance and isoluminance diagrams can also be obtained. The program can be used as a design tool in the following way. For a chosen road geometry and a selected luminaire type, the designer can determine the performance of a proposed lighting design by calculating the relevant performance measures and comparing the results with the current accepted, or the proposed new standards. Many different designs can be rigorously evaluated in a short time. In conjunction with photometric measurements, the program was used to evaluate the performance of the existing design on the Toronto Bypass (Canada). Lighting designs based on calculations of luminance and disability veiling brightness are preferred

to those based on illuminance because nighttime visibility is determined by the former rather than the latter.

by F. W. Jung; C. Blamey  
Ontario Ministry of Transportation and Communications, Res. and Devel. Div., Canada  
Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p25-32  
1977; 10refs  
Sponsored by Com. on Visibility.  
Availability: In HS-022 149

HS-022 155

# **LIMITATION OF DISABILITY GLARE IN ROADWAY LIGHTING**

The limitation of disability glare from luminaires by specifying a minimum value of effective relative contrast sensitivity for a particular road class is proposed. A simple formula has been derived for the effective relative contrast sensitivity of a lighting system by using curve-fitted, standardized data. Glare control by limiting the relative contrast sensitivity can be achieved by a permissible glare formula or a diagram. The method is demonstrated by examples. Control of relative contrast sensitivity glare can also be combined with a method that is based on limiting the threshold increment of a critical-size object. The relative contrast sensitivity method and the visibility index method both use the same concept of contrast sensitivity change with glare.

by F. W. Jung  
Ontario Ministry of Transportation and Communications, Res. and Devel. Div., Canada  
Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p33-7  
1977; 11refs  
Sponsored by Com. on Visibility.  
Availability: In HS-022 149

HS-022 156

# **EVALUATING NIGHTTIME SIGN SURROUNDS**

The accuracy of a variety of instruments that might be suitable for field measurement of nighttime sign surrounds was evaluated by comparing measurements made with them with measurements made with a laboratory-quality telephotometer. A technique for the evaluation of surrounds that identifies them by luminance measurements was developed. The measurement of numerous surrounds leads to the conclusions that conventional descriptions are often inappropriate, that opposite sides of the same roadway may vary in luminaire intensity, and that roadway geometrics may cause variations in surrounds. Photographs and luminance values that represent four generalized luminance levels and a description of each are presented.

by H. L. Woltman; W. P. Youngblood  
Minnesota Mining and Manufacturing Co., Saint Paul  
Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p44-8  
1977; 14refs  
Sponsored by Com. on Visibility.  
Availability: In HS-022 149



HS-022 157

# **POOR VISIBILITY UNDER LOW-BEAM HEADLIGHTS: A COMMON CAUSE OF WRONG-WAY DRIVING**

Since wrong-way driving is commonly caused by poor visibility of roadway signs, such devices should be located on the basis of their legibility under low-beam headlights at night. The zone of legibility at night is not conical as has been supposed but is keg-shaped; the keg of legibility concept should be applied to placement of signs, markings, and other guidance devices. Three case examples are given of intersections at which such a concept should be used: interstate highway exit ramp and secondary road; interstate highway ramps and primary highway; and divided primary highway and secondary road. Diagrammatic signs should be used to provide guidance at intersections having poorly designed features such as differences in elevation between the opposite lanes of four-lane divided highways, crossroads that slope down from divided highways, or wide crossovers that could lead to wrong-way entries. A diagrammatic sign depicting a divided-highway intersection should be placed below the stop sign at the junction of a crossroad and a divided highway to inform the driver of the geometry of the intersection. A diagrammatic turn sign should be placed on the nose of the median to inform the driver of the location of the left-median nose and the need for turning around it. At intersections of crossroads and highway exit ramps, the marking on the edge of the pavement of the crossroad should be continued across the exit, or the stop line on the exit ramp should be brought within the keg of nighttime legibility of a driver on the crossroad. On parclo interchanges having the exit and entry ramps very close together, the median should extend to the edge of the crossroad, and its nose should be made of concrete and painted with reflective material.

by N. K. Vaswani  
Virginia Hwy. and Transportation Res. Council,  
Charlottesville, Va.  
Publ: HS-022 149 (TRR-628), "Lighting, Visibility, and Railroad-Highway Grade Crossings," Washington, D.C., 1977 p52-6  
1977; 3refs  
Sponsored by Com. on Visibility.  
Availability: In HS-022 149

HS-022 158

# **FATIGUE UNDER COMPLEX LOADING: ANALYSES AND EXPERIMENTS**

Ten papers have been produced as a result of a single experimental study on cumulative fatigue damage, performed by various organizations. All participants used the same three field load histories considered to be typical of the ground vehicle industry. The SAE program as a whole is described, notched member fatigue life predictions are made by the local strain approach, and fatigue life prediction is made of automotive-type load histories. Fatigue life predictions for a notched member under complex load histories are made, as are spectrum fatigue life predictions for typical automotive load histories and materials using sequence accountable fatigue analysis. Predictions are also made for a notched plate with analysis of mean stress and overstrain effects, and the accuracy of simplified fatigue prediction methods is considered. Shortcuts in cumulative damage analysis are described, and predictions made of cumulative fatigue damage using condensed load

histories. A Neuber's rule fatigue analysis procedure for with a mobile computer is described, and nominal stress/ local strain approaches to cumulative damage are discussed.

by R. M. Wetzel, ed.  
Society of Automotive Engineers, Cumulative Fatigue Damage Div.  
Rept. No. SAE-AE-6; 1977; 196p refs  
Includes HS-022 159--HS-022 161. Based on experimental study, 1970-1974.  
Availability: SAE

HS-022 159

# **NOTCHED MEMBER FATIGUE LIFE PREDICTION BY THE LOCAL STRAIN APPROACH**

The local strain approach to notched member fatigue life prediction can effectively handle local notch plasticity, stress effects, complex geometric shapes, and load versus histories of any degree of irregularity. Needed material properties may be obtained by testing small laboratory specimens. If information is lacking on a new material, preliminary predictions may be made if two small laboratory specimens can be tested, one in monotonic tension and the other to obtain the cyclic stress/strain curve. Extensive test data analyzed from a program in which notched members made of two commercial steels were subjected to vehicle service histories.

by N. E. Dowling; W. R. Brose; W. K. Wilson  
Westinghouse Res. Labs.  
Publ: HS-022 158, "Fatigue Under Complex Loading: Analyses and Experiments," Warrendale, 1977 p55-84  
1977; 87refs  
Availability: In HS-022 158

HS-022 160

# **FATIGUE LIFE PREDICTION OF AUTOMOTIVE-TYPE LOAD HISTORIES**

A method is presented for predicting fatigue lives of material fatigue tests and component fatigue tests to prevent failures from an applied load sequence. Predicted lives correlate with actual lives when the following conditions are met: nominal stresses remain elastic; component fatigue tests conducted at load levels similar to those experienced in load history; sufficient data are available for determining median properties; and sources of variability for the constant amplitude tests and the field tests are similar. Determination of the load fatigue concentration factor can be made without stress analysis of the component. Alteration of the material cyclic stress/strain properties to best fit the component fatigue tests allows reasonable estimates of fatigue life with completely accurate knowledge of material properties.

by Thomas M. Johnson  
General Motors Proving Ground, Noise and Vibration Lab.  
Publ: HS-022 158, "Fatigue Under Complex Loading: Analyses and Experiments," Warrendale, 1977 p85-93  
1977; 5refs  
Availability: In HS-022 158

HS-022 161

### FATIGUE LIFE PREDICTIONS FOR A NOTCHED PLANE WITH ANALYSIS OF MEAN STRESS AND OVERSTRAIN EFFECTS

A method has been developed to implement the local stress/strain approach to fatigue of notched components. Examination of the events which occur during one block of loading after the stress/strain response has stabilized are used to predict crack initiation life under repeated applications of the loads. Application to a large body of component fatigue data has resulted in accurate initiation life predictions. The stable cyclic stress/strain curve is used to simulate the stress/strain response from an input strain history. An algorithm developed for computer implementation simulates stress/strain behavior, detects the closure of stress/strain loops, and assigns damage to each. The cyclic load-notch strain curve is used to generate the local strain response from the applied load history in a manner similar to that used to generate stress/strain response from strains. Accessibility to these techniques is facilitated by the presentation of flow charts and computer program listings. Analysis of the effect of mean stresses as altered by mean stress relaxation is made by comparing life predictions under the maximum and minimum influence of the effect. Analysis of the overstrain effect is made in the same way. Predictions made with maximum and minimum mean stress effects show a relatively consistent difference in life for each material-history combination never greater than a factor of two. By contrast the overstrain effect for RQC-100 steel increases from no influence at short lives to a very large influence at long lives which overweights the mean stress effect. The overstrain effect has insignificant influence on life for Man-Ten steel. Appended to the report are Fortran programs for stress/strain simulation and damage calculations and for calculating strains from applied loads.

by W. R. Brose

Westinghouse Res. Labs.

Publ: HS-022 158, "Fatigue Under Complex Loading: Analyses and Experiments," Warrendale, 1977 p117-35

1977; 28refs

Supported by Advanced Res. Projects Agency and by Univ. of Illinois Coll. of Engineering, Fracture Control Prog.

Availability: In HS-022 158

HS-022 162

### PUBLIC INVOLVEMENT TECHNIQUES OUTLINED IN HIGHWAY AGENCY ACTION PLANS. VOL. 1. ANALYSIS OF PARTICIPATORY TECHNIQUES

Thirty techniques for participation of the public in highway planning are described. About half the techniques are merely informative: the other half are those in which the public is involved in a two-way dialog with the planning authorities. Involvement programs which are open to participation and discussions with the population at-large include such techniques as public hearings, information meetings, pre-hearing and post-hearing meetings, public workshops, public forums, televised planning discussions, resource base analysis, and project field reviews with citizens. The aforementioned techniques are also time-specific in their application, that is, they occur at definite points in time during the project's development. The remaining public involvement techniques rely more upon the participation of individuals and generally occur over a time continuum. These involvement techniques include citizens committees, speaking engagements with in-

terested parties, conducting field surveys, personal interviews, project field offices, and telephone hotlines. By determining which population segments they want to reach, highway agencies utilize information techniques to disseminate project-related materials or notices to a variety of audiences. Widespread exposure to a number of diverse publics may be achieved through techniques such as legal notices, mass media advertisements, news releases, publishing project development schedules, audio-visual presentations, mass mailouts, and press conferences. Project-related announcements which may be directed at more well-defined community or neighborhood populations include billboard advertisements near the project, announcements on local bulletin boards, and public information displays. Notices of highway development activities and project data are often exchanged between highway agencies and specific individuals (such as affected property owners), groups, or institutions. These notices may be conveyed through mailing lists, circulating project reports, newsletters, response forms, citizen band radio announcements, and by other means. Techniques for informing the public may be implemented at virtually any time during the project development process.

by William M. Wood

Federal Hwy. Administration, Office of Environmental Policy, Washington, D.C.

1977; 57p

Includes oversize chart. Vol. 2 is HS-022 163.

Availability: Corporate author

HS-022 163

### PUBLIC INVOLVEMENT TECHNIQUES OUTLINED IN HIGHWAY AGENCY ACTION PLANS. VOL. 2. ACTION PLAN PUBLIC INVOLVEMENT SUMMARIES

Summaries are presented of the Action Plans of all 50 states, Puerto Rico, and the District of Columbia for public involvement in highway planning. Public involvement in Federal highway projects is also conducted. Data are current as of Fall 1976.

by William M. Wood

Federal Hwy. Administration, Office of Environmental Policy, Washington, D.C.

1977; 185p

Vol. 1 is HS-022 162.

Availability: Corporate author

HS-022 164

### THE CASE FOR THE NEW-BREED POLICE CARS

Police cars are getting smaller, safer, more reliable, quicker, and easier to drive. A saving of \$138 million a year is anticipated when conversion to compact cars is complete. A seven-phase program of individual tests and evaluations was developed to predict the future behavior, longevity, and serviceability of police cars. The tests included a pass-fail speed test and a series of high speed stops, acceleration from rest and from urban and highway traffic speeds, two braking fade tests, emergency handling and steady-state handling. An exhaustive heat test measured under-hood air, engine oil, power steering and transmission fluid, and radiator coolant temperatures, both at idle and under hard usage. A fuel economy test under urban, suburban, and freeway conditions was run with

air conditioners, headlights, and radios in operation. An ergonomic or human factor and space utilization evaluation was carried out. Mechanical ratings tests covered day-to-day serviceability and maintenance ease, and a predictive evaluation of time, ease, and cost of major repairs. Communications ratings included ease of installation, component placement, and conductor routing. A Chevrolet police adaptation of the Nova ("NASCAR Nova") and the Volvo 164E were the best performers in the test, with the Nova being less costly. A 20,000 mile test of Novas and Plymouth Furys indicated that the compact car provided a fuel saving of over 600 gallons. When maintenance and tire costs were included, the Nova's operational costs were 8.1 cents per mile versus the Fury's 11.8 cents per mile. Statistics on accident cost rates indicated that the compact police car is demonstrably safer. The lower accident rate is due to better evasive capabilities and excellent visibility. Cars (1976 models) that passed the preliminary pass-fail test included a Dodge Dart, a Fury, a Pontiac LeMans, a Mercury Montego, a Nova, and a Ford Torino, with the Nova having the best overall score. The new police cars are more efficient in handling and performance, due to careful engineering and suspension selection. A reduced fatigue factor is also apparent.

by John Christy  
Publ: Motor Trend v28 m6 p75-81 (Jun 1976)  
1976  
Availability: See publication

## HS-022 165

### METHODOLOGY OF AN IN-DEPTH ACCIDENT INVESTIGATION SURVEY

A survey was made of over 2000 accidents which occurred in a certain area of South East Berks., England, between 9 Mar 1970 and 28 Feb 1974, the principal objective being to identify accident causation factors. An accident investigation team was formed to survey an accident scene upon notification by the police. Procedures included a preliminary assessment, photographs and notations of each vehicle, vehicle damage and position, locations of tire marks, debris, etc., details of road and layout, as well as environmental features. A scale sketch plan was made. Road users involved were interviewed, subject to their agreement, and other procedures were carried out as necessary, such as examination of involved vehicles in garages and follow-up visits to the accident site. Later, brake examination became part of the investigation procedure. Accident injury severity was assessed from hospital reports and fatality details were elicited from Coroners' Courts. Assessment of accidents relied on three types of evidence, factual, testimony from interviews, and weighed evidence leading to allotment of accident responsibility to the road user, the vehicle, or to the road environment. Data were collected on a standard form and coded for computer processing using FORTRAN programs. The most important outcome of the On-the Spot Accident Survey was the assessment of contributory factors in accident causation.

by G. C. Staughton; Valerie J. Storie  
Transport and Rd. Res. Lab., Accident Investigation Div.,  
Crowthorne, Berks., England  
Rept. No. TRRL-LR-762; 1977; 37p 15refs  
Availability: Corporate author

## HS-022 166

### ESTIMATION OF DISTANCES WHILE DRIVING

The capability of drivers to make absolute and relative distance judgments from a vehicle travelling at a range of speeds was studied using 32 randomly selected drivers on a 75-mile route along which were 23 targets or features. Subjects were required to say when they were 1000 ft from the various targets and then had to either halve or quarter the distance. The range of values obtained for a specified distance indicate that drivers in general would be unable to estimate accurately distances given to them in feet. Drivers in general underestimated absolute distances, with the underestimation greatest at lower speeds. In relative judgments, the shorter the overall distance the more accurate was the judgment when fractioning. In general, however, drivers did tend to overestimate distances relative to each other, i.e. the fractions were always larger than required. Estimates of relative distances, unlike those of absolute distances, were unaffected by speed.

by Georgina M. Burney  
Transport and Rd. Res. Lab., Rd. User Characteristics Div.,  
Crowthorne, Berks., England  
Rept. No. TRRL-SR-262; 1977; 10p 2refs  
Availability: Corporate author

## HS-022 167

### ROAD TRAFFIC ACCIDENTS IN FINLAND 1974 WITH SOME ADDITIONAL FIGURES STARTING FROM THE YEAR 1955 (SUOMEN TIELIKENNEONNETTOMUDET VUONNA 1974 LISANA ERAITA TIETOJA VUODESTA 1955 ALKAEN)

Tables, graphs, and maps present data on the following aspects of highway accidents in Finland for 1974: killed and injured in road traffic accidents; killed and injured by age groups; pedestrians, cyclists, mopedists, and motorcyclists killed and injured by age groups; and vehicles involved in road traffic accidents. Other data presented include fatalities and injuries per 1000 cars and per 100,000 mean population, by province; fatalities and injuries by month, by day of week, and by hour of day; and injury accidents by type of damage. Also included are data on the following: pedestrian action at the time of accident and by age groups; motor vehicle casualties by action of driver and by vehicle group; accidents by degree of illumination and by weather conditions; accidents at railroad crossings; and intoxicated fatalities and injured. Other data concern accidents and their consequences per 100 million vehicle kilometers, cost of accidents, and accident statistics of some other European countries in 1973. The number of motor vehicles in Finland in 1965-1974 is given, as is the number of deaths per 1000 motor vehicles. Those killed and injured in road traffic accidents in 1955 through 1974 are listed by number, per 1000 vehicles, per one million mean population, per 1000 accidents, and by age groups.

Liikenneturva, Finland  
1976; 41p  
Text in Finnish and English.  
Availability: Corporate author

HS-022 168

**1977 MOTORCYCLE STATISTICAL ANNUAL**

Statistics are presented and discussed which deal with the motorcycle market, manufacturers and distributors, the aftermarket, the retail marketplace, motorcycle usage, and the motorcycle owner. Market statistics include the following: descriptions of the U.S. motorcycle population by model type, engine displacement, and year, and penetration by region and state; total registrations by year and by state; economic value of the motorcycle industry by state; new motorcycle sales summary; imports by year, country, and engine displacement; wholesale sales by major brands; registrations by state and by leading brands. Major U.S. motorcycle manufacturers and distributors are profiled, and others are mentioned, as are moped (motorized bicycle) manufacturers and distributors. A profile is given of the aftermarket manufacturers and distributors; top selling aftermarket products, and financing of aftermarket sales are described. Retail outlets by state are considered, as well as retail sales by franchised dealers with a profile of the dealer. Usage statistics include the following: on road and off road usage by state; street usage, commuting, and other purposes; miles traveled, on and off road mileage by model type; model type by on and off road mileage; average annual mileage; operability rate; operating and ownership costs; accidents by state; rider education programs; licensing operator procedures; and equipment requirements. A profile is given of the motorcycle owner.

Motorcycle Industry Council, Inc., Res. and Statistics Dept.,  
4100 Birch St., Suite 101, Newport Beach, Calif. 92660  
1977; \$2p  
Availability: Corporate author \$5.00

HS-022 169

**ANTI-LOCK BRAKING SYSTEM FOR PASSENGER  
CARS: DEVELOPMENT OF A BRAKE SYSTEM  
GIVING YAW STABILITY AND STEERABILITY  
DURING EMERGENCY BRAKING**

A working program for the development of an antilock system for cars was started in 1961. The main principle for the system control was to sense rotational wheel slip and to maintain a predetermined wheel slip as close as possible. Wheel slip is defined as a measure of the rotational speed of a wheel in relation to the free rolling speed of the wheel. In 1967 a brake control system was presented and installed in a passenger car with one unbraked rear wheel which was used to achieve a reference speed. In 1968 application for patent was made on a system with individual wheel slip control on all wheels with alternating brake release on the rear wheels for reference speed measurement. A brake control system according to this principle was then developed and tested in a passenger car on ice with studded tires and on dry asphalt concrete with ordinary diagonal tires. The brake tests on ice were made from an initial speed of 50 km/h with a curve radius of 100 m and the asphalt tests were made from 75-80 km/h with a curve radius of 50 m. The vehicle could be steered along with marked curve periphery both on the ice track and on the dry asphalt track. The initial speed on ice was equal to the limit speed for driving with constant speed. On the asphalt track the speed was so high that the curve radius could not be maintained at constant speed. Yaw stability was very good under all testing conditions; no tendency to get a large side slip angle on the vehicle was found. The braking efficiency with the control system ac-

tive was always better on ice and slightly lower on dry asphalt compared with locked wheel braking. The reliability of the system has been good during the limited number of tests that have been made. More work remains before the system can be marketed. The system can be easily reprogrammed. It will be useful for studies of the ability of drivers to use the steerability during braking in different situations.

by Gosta Kullberg; Olle Nordstrom; Goran Palmkvist  
National Rd. and Traffic Res. Inst. (VTI), Fack S-58101  
Linköping, Sweden  
Rept. No. VTI-100A; 1977; 58p  
Financed by National Swedish Board for Technical  
Development, National Swedish Rd. and Traffic Rd. Inst.,  
Eighty Year Fund, and Transport Res. Commission.  
Availability: Corporate author

HS-022 170

**SAN DIEGO WHEELCHAIR ACCESSIBLE BUS  
STUDY. INTERIM REPORT**

The San Diego, Calif., Transit Corp. began a pilot demonstration program 6 Feb 1976 of wheelchair-accessible transit coaches retrofitted with wheelchair lifts by Transportation Design and Technology, Inc. Four such full-sized buses ran regular, fixed-route services approximately hourly on two heavily patronized routes; a fifth was reserved as a spare. There have been relatively few mechanical problems with the lift equipment. Small design changes included reducing the height of the lift platform edge and relocating hydraulic lines to improve performance. Costs involved in setting up such a service include those of retrofitting the buses, extra maintenance, reduced seating capacity by four to six seats, and added dwell time. The service probably will not require additional vehicles, however, to maintain overall capacity and schedule reliability. During the first week of lift-bus service, ridership averaged slightly less than two trips per day. In early Apr, ridership had dropped to about one person per week. Factors which may have caused such low use include the following: a lack of advertising or marketing of the wheelchair lift service due to budget constraints; the limited origins and destinations served by wheelchair buses; the difficulty of accessing the bus stops or destinations near the bus stops due to street curbs and the hilly terrain found in many sections of San Diego; the competition from social service agency transportation services and from the City of San Diego Dial-A-Ride; and the initial unreliability of the service due to late delivery of some of the vehicles and the absence of a back-up vehicle when the lift design improvements were being incorporated. Appended to the report are the results of a dial-a-ride passenger survey and newspaper articles publicizing the lift-bus service.

by Robert F. Casey  
Transportation Systems Center, Kendall Square, Cambridge,  
Mass. 02142  
Rept. No. UMTA-MA-06-0049-77-8; DOT-TSC-UMTA-77-41;  
1977; 54p  
UMTA/TSC Transit Dependent Transportation Series. Service  
and Methods Demonstration Prog. PPA-UM-727. Rept. for  
Feb-Apr 1977.  
Availability: NTIS

HS-022 171

**INTERNATIONAL FEDERATION FOR HOUSING  
AND PLANNING, CONGRESS, HELSINKI, AUGUST**

**1976. WORKSHOP OF THE STANDING COMMITTEE ON TRAFFIC PROBLEMS (I.F.H.P.) IN COOPERATION WITH THE INTERNATIONAL FEDERATION OF PEDESTRIANS (IFP)**

Nineteen papers are presented which deal with pedestrian and bicyclist safety, particularly of school children. Related subjects include pedestrian crossings, separation of bicycle from vehicle traffic, pedestrian crossings in Japan, nighttime factors, and pedestrian bridges. Other subjects include driver fault in pedestrian-related collisions, human factors research, the work of the World Health Organization, and the role of government. Several papers deal specifically with children and traffic safety, and with the pedestrian behavior of the aged.

International Federation of Pedestrians, International Federation for Housing and Planning  
1977; 130p refs

Cover title: "The Voice of the Pedestrian VII: (La Voix du Pionnier VII; Die Stimme des Fussgangers VII)." One paper is in German.

Availability: General Secretary of the International Federation of Pedestrians, 61/III, Passage, The Hague, The Netherlands

HS-802 416

**DATA BASE FOR LIGHT-WEIGHT AUTOMOTIVE DIESEL POWER PLANTS. VOL. 1. SUMMARY REPORT**

Various engine/vehicle systems were tested for the effects of diesel powerplants on fuel economy, emissions, crashworthiness, initial cost, durability and maintenance, and performance, driveability, and startability. Vehicles tested included Volkswagen Rabbit, Dasher, and Audi. Composite fuel economy of vehicles in the 2250-to-3000 lb inertia weight (IW) range equipped with naturally aspirated (NA) diesel engines with nominal Environmental Protection Agency (EPA) road load setting varies by 24%, 41 to 33 mpg at constant performance level. Fuel economy value at 2250 lb IW with an EPA road load setting that reflects the actual road load is 44 mpg. Composite fuel economy of turbocharged diesel engines is 20% higher than that of naturally aspirated diesel engines, and can be improved by 10% using drivetrains designed for optimal fuel economy. Varying the horsepower-to-weight ratio from 0.030 to 0.022 leads to an increase of the composite fuel economy by 8% in NA diesel engines. Changing the emission level from 0.41/3.4/2.0 to 0.41/3.4/1.0 g/mi HC/CO/NOx causes fuel economy to drop by 5% with some other adverse effects. It is possible to meet an emission level of 0.41/3.4/2.0 g/mile hydrocarbon/carbon monoxide/oxides of nitrogen with all engine vehicle systems under consideration. During normal road operation the smoke emitted by all engine/vehicle systems was invisible. Compared to current engine technology, the amount of particulates emitted is low, but it is increased when exhaust gas recirculation (EGR) is used. Odor level of the engines studied is in the range of modern designed passenger car diesel engines, but increases when EGR is used. Actual sulfates emissions are largely dependent on the sulfur content of the fuel used. The emissions of ammonia and aldehydes compare to those of spark ignition engines. First measurements of polynuclear aromatic hydrocarbon emissions indicate lower values than those of gasoline engines. The acceleration noise of diesel and gasoline engines (with identical HP/IW) is the same. Gasoline engines produce slightly less noise when idling or cruising. Acceleration performance (0-60 mph) of diesel engine powered vehicles (2000-3000 lb) ranges from 11 to 20 sec,

similar to vehicles equipped with spark ignition engines. Under U.S. operating conditions, fuel composition, and lubricants, driveability as well as startability present no major problems. All engines studied exhibited no startability problems above minus 11° F (-25° C). The maintenance requirements of modern diesel engines are lower than those of comparable gasoline engines. Based on test data and engineering analysis the service life of the diesel engines studied exceeds the service life of equivalent gasoline engines. The higher cost of diesel engine is partly offset by emission control measures required by gasoline engines. The price for the NA 4 cylinder Rabbit Diesel is \$170 higher than of an equivalent gasoline version. Installation of diesel engines complies with safety requirements, and does not entail significant changes in either vehicle geometry or weight. The more advanced diesel engine offers definite advantages in terms of engine performance and vehicle packaging. To demonstrate the compatibility of a turbocharged diesel power plant, 4 cylinder 70 HP, five speed manual transmission with a vehicle of advanced safety features, high performance, acceptable emissions, and good fuel economy, an Integrated Research Vehicle (IRVW) was built.

by B. Wiedemann; R. Schmidt et al  
Volkswagenwerk, Res. Div., 3180 Wolfsburg, Federal Republic of Germany

Contract DOT/TSC-1193

Rept. No. DOT-TSC-NHSTA-77-3.1; 1977; 148p

Full report is in two volumes, HS-802 417 and HS-802 418.

Final rept. for 30 Jun 1976-30 Jul 1977.

Availability: NTIS

HS-802 506

**MANUAL FOR POLICE TRAFFIC SERVICES. PERSONNEL PERFORMANCE EVALUATION SYSTEM. VOL. 1. MANAGEMENT AND IMPLEMENTATION**

An evaluation system was developed, relating to highway safety through law enforcement agencies that provide police traffic services; use of the system will help such agencies determine if the quantity and quality of the Police Traffic Services (PTS) they provide are at acceptable levels. A reasonably precise measure of a patrolman's actual performance of police traffic services is afforded; specific, defined parts of the patrolman's job as well as the quality of performance are assessed. By aggregating such individual data the performance of a group, a shift or even an entire department may also be evaluated, and the effectiveness of a particular safety or enforcement program assessed. Police traffic services, their operational importance and management uses of personnel evaluation are presented as background; development of the PTS Personnel Performance Evaluation System is described; and the System Implementation and Application is then explained. The unique and most important feature of the system is that it measures actual job performance (and output) against quantitative standards. The system was primarily developed for use by first line supervisory personnel to assess the traffic service performance of their individual officers. A Model Job Description is presented which defines all the activities that could be part of the job of a patrolman in carrying out traffic services. It includes a definition of each duty and primary task presented at the left, and in adjacent columns information about products, the observability and universality of each task, training activities, and gradations in quality of per-

driver habits) and control variables (statistical similarity of two groups) as well as the principal comparison of interest, PMVI vs. no PMVI. The principal accomplishment of this study was the preparation and publication of the Motor Vehicle Inspection Program Evaluation Procedures Manual and the documentation covering computer program development and use. The field evaluation effort successfully demonstrated the application of technique and the cooperation of a cognizant state authority. The other significant accomplishment of the study was the generation of an experiment design for the assessment of the impact of PMVI on accident involvement. The proposed design, if implemented, would provide the data by which the link between vehicle condition and accident frequency could be quantified.

**FOR POLICE TRAFFIC SERVICES.  
EL PERFORMANCE EVALUATION  
VOL. 2. SUPERVISOR'S GUIDE**

on system described provides a reasonably precise measure of a patrolman's actual performance of traffic services. It allows the supervisor, typically the sergeant, to assess the performance of each of his men and to identify their strengths and weaknesses within his platoon. The system is based on a specific set of factors, each representing a segment of police traffic services; the supervisor is not to make a separate judgment of a patrolman's work on each factor, based on information concerning the patrolman's traffic service activities. Specific instructions for the use of the system are presented, along with the forms used for data collection and evaluation processes. The unique feature of the system is that it measures actual job performance (and not just potential) against quantitative standards. For every measure, the supervisor must clearly indicate a range of values that he feels are acceptable work. Evaluative Factors are provided, one for each of the eight factors of traffic services. For each factor, there are three rating levels: performance, analysis of performance, and narrative. Specific rating instructions are given. Examples of the Evaluative Rating Forms are appended, as are blank forms for the PTS Evaluation System.

ny. Traffic Safety Administration, Washington,

5-802 506.  
: GPO

**STATUS DATA COLLECTION  
OLOGY, VOL. 1: SUMMARY REPORT  
REPORT [PERIODIC MOTOR VEHICLE  
[ON]**

al activities and achievements in accomplishing the two objectives are summarized: development of In-gram Evaluation Procedures which can be used by Federal officials to measure the effectiveness of motor vehicle inspection (PMVI) systems in reducing the defect level below that which would exist in the state inspection; and designing an experiment to assess the presence of a federally recommended PMVI system. The experiment will measure the effectiveness of procedures developed to determine the effectiveness of inspection consist of both field and inspection measures. Field evaluations involve the measurement of vehicle-in-use (VIU) condition (for cars only) as a function of time since inspection. In-gram evaluations involve the assessment of the

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Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-Vol-1; 1977; 36p 6refs  
Rept. for Jul 1975-May 1977. See also HS-802 572--HS-802 576.  
Availability: NTIS

HS-802 572

**SAFETY STATUS DATA COLLECTION  
METHODOLOGY. VOL. 2: TECHNICAL REPORT ON  
DEVELOPMENT AND VALIDATION OF  
EVALUATION PROCEDURES. FINAL REPORT  
[PERIODIC MOTOR VEHICLE INSPECTION]**

The technical development and justification are presented for inspection program evaluation procedures which can be used by state and Federal officials to measure the effectiveness of periodic motor vehicle inspection (PMVI) systems in reducing the vehicle defect level below that which would exist in the absence of state inspection. The focus of the work was the development of evaluation procedures for PMVI states; however, the procedures that were developed are also applicable to title-transfer-only inspection states. The procedures developed consist of both field and inspection stringency measures. Field evaluations involve the measurement and assessment of vehicle-in-use (VIU) condition (for passenger car only) as a function of time since inspection. Inspection stringency evaluations involve the assessment of the operational condition and performance of state-approved inspection stations. The procedures were validated both analytically and operationally. The field validation of the procedures was conducted in St. Louis, Mo., and successfully demonstrated the application of technique and the cooperation of a cognizant state authority. The mathematical formulation and detailed technical basis for the field evaluations are appended; three of the four appendices are heavily mathematics-oriented; while the fourth appendix contains a qualitative and intuitive explanation of the relevance of models to the problem at hand.

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Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-Vol-2; 1977; 225p 8refs  
Rept. for Jul 1975-May 1977. See also HS-802 571; and HS-802  
574-HS-801 576.  
Availability: NTIS

HS-802 573

HSL 78-05

HS-802 573

**SAFETY STATUS DATA COLLECTION  
METHODOLOGY. VOL. 3: TECHNICAL REPORT ON  
PMVI EXPERIMENT DESIGN. FINAL REPORT  
[PERIODIC MOTOR VEHICLE INSPECTION]**

The technical results of a study to design an experiment which relates the presence of a federally recommended periodic motor vehicle inspection (PMVI) system to accident, fatality, injury, and property damage level, are presented. The experiment developed considers exogenous variables (such as topography, demographics, driver habits) and control variables (statistical similarity of two groups) as well as the principal comparison of interest, PMVI vs. no PMVI. The experiment is statistically valid if followed as prescribed. It may be considered costly, and legislation will probably be required to mandate participation by all members of the population selected. The essential ingredient in the experiment lies in the creation of two groups (PMVI and no-PMVI) to be tested. A single population is chosen, and a random dichotomy is made to define the two test groups. A prescribed PMVI is provided one group in which members are randomly assigned inspection dates. Several experimental designs, such as the Latin Square, are applicable here depending upon availability of time and funds. The experiment may be conducted testing total accident rates or defect-induced accident rates, the latter determined with accident-investigation teams. Relative cost is a principal determining factor here. Also of potential interest is the time design, which tests whether accident rate increases with time since last inspection in a PMVI state. The results from such an experiment are only valid for the PMVI state in question, and whether inferences can be drawn therefrom to difference in effect of PMVI and no PMVI for states in general is a question open to subjective interpretation. Large sample sizes are required to test the effect of interest. Attention is directed to understanding the fundamental limitation posed by the basic model in requiring such large sample sizes. It is the proportion statistic which sets the demand for large sample sizes; where other underlying probability distributions are applicable to the model, fewer samples are needed. For example, instead of measuring only injury rate (involving proportion statistics), a more effective test, requiring smaller sample size, is applicable to testing cost of injury (involving continuous distributions). Test results for existing state data are provided to illustrate what can be done with existing data and at the same time to show how inappropriate they are for testing the PMVI effect.

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Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-Vol-3; 1977; 98p 28refs  
Rept. for Jul 1975-May 1977. See also HS-802 571, HS-802 572, and HS-802 574-HS-802 576.  
Availability: NTIS

HS-802 574

**SAFETY STATUS DATA COLLECTION  
METHODOLOGY. VOL. 4: UPDATE OF VEHICLE  
IDENTIFICATION CODE. FINAL REPORT  
[PERIODIC MOTOR VEHICLE INSPECTION]**

An update of the National Hwy. Traffic Safety Administration (NHTSA) motor vehicle identification code is presented. To operate the NHTSA computer programs PROCES and MAIN, a motor vehicle identification code is used. This code, called

the Ultra Code, maps vehicle make/model names into code numbers for ease of computer handling. The update (1974, 1975, 1976, and 1977 model years) is incorporated with the original code (for vehicles through model year 1973) and presented by vehicle make classification. Since the update work was performed in the first quarter of 1977, later 1977 model productions are not included.

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AVCO Corp., Avco Systems Div., 201 Lowell St.,  
Wilmington, Mass. 01887  
Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-Vol-4; 1977; 41p  
Rept. for Jul 1975-May 1977. See also HS-802 571-HS-802 573, HS-802 575, and HS-802 576.  
Availability: NTIS

HS-802 575

**SAFETY STATUS DATA COLLECTION  
METHODOLOGY. VOL. 5: MOTOR VEHICLE  
INSPECTION PROGRAM EVALUATION  
PROCEDURES MANUAL. FINAL REPORT**

The steps necessary for implementation of inspection program evaluation procedures by state or Federal authorities for use in assessing their periodic motor vehicle inspection (PMVI) programs are presented. To evaluate the effectiveness of a motor vehicle inspection system, the vehicle-in-use (VIU) condition of passenger cars and the operational condition and performance of the inspection stations must be determined. The VIU condition assessment is called Field Evaluation; the inspection station assessment is termed Inspection Stringency Evaluation. The three important steps to the implementation of the Inspection Program Evaluation Procedures are Planning, Field Operation, and Analysis. The focus of this document is on what to do and how to do it. As an aid in understanding the implementation steps, illustrated examples are presented.

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Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-vol-5; 1977; 65p 3refs  
Rept. for Jul 1975-May 1977. See also HS-802 571-HS-802 574 and HS-802 576.  
Availability: NTIS

HS-802 576

**SAFETY STATUS DATA COLLECTION  
METHODOLOGY. VOL. 6: COMPUTER  
DOCUMENTATION. FINAL REPORT [PERIODIC  
MOTOR VEHICLE INSPECTION]**

Computer documentation which is required to utilize the data collected by state or Federal authorities, using inspection program evaluation procedures, in an effort to assess their periodic motor vehicle inspection (PMVI) programs, is presented. To evaluate the effectiveness of a motor vehicle inspection system, the vehicle-in-use (VIU) condition of passenger cars and the operational condition and performance of the inspection stations must be determined. The VIU assessment is called field evaluation; the inspection assessment is termed inspection stringency evaluation. The information necessary to the operation of the computer programs developed to analyze data from the PMVI evaluations is pro-

modification of these programs by computer specialists is presented in the Programmer's Manual which contains flow charts, narrative descriptions of the coding, and program listings.

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Contract DOT-HS-5-01159  
Rept. No. AVSD-0109-77-RR-Vol-6; 1977; 120p  
Rept. for Jul 1975-May 1977. See also HS-802 571--HS-802 575.  
Availability: NTIS

HS-802 585

### RESPONSE OF CADAVER TEST SUBJECTS IN BELT RESTRAINTS. FINAL REPORT

Seven unembalmed cadavers were subjected to simulated flat-barrier collisions to evaluate the effectiveness of various types of restraint systems. The deceleration profiles for the two vehicle types simulated and the representative restraint systems utilized were as follows: 1974 full-size automobile, front-seat production lap and shoulder belt with retractors, velocity change of 30 mph; 1974 compact automobile, front-seat production lap and shoulder belt with retractors, velocity change of 25 mph; and 1972 compact automobile, front-seat prototype Inflataband (Allied Chemical Corp.), velocity change of 32 mph. Each test was highly instrumented, and a detailed autopsy following each test was made to determine and document the extent of bodily injury sustained during the impact in accordance with the Abbreviated Injury Scale (AIS) formulated by the American Medical Assoc. The results of these examinations indicate that severe thoracic and cervical injuries (including multiple rib fractures, and fractures of the sternum, clavicle, and cervical vertebrae) are induced by the belted restraint systems. No injuries to the cadaver were observed when restrained by the Inflataband.

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78284  
Contract DOT-HS-4-00998  
Rept. No. SwRI-AR1159; 1977; 207p 3refs  
Rept. for 28 Jun 1974-15 Apr 1977.  
Availability: NTIS

HS-802 591

### CONSTRUCTION OF A COMPREHENSIVE CAUSAL NETWORK. PHASE 3: FINAL REPORT (VOL. 1)

A comprehensive causal network was constructed which gives a conceptual framework for motor-vehicle accident causation. The network is organized under two aspects: the accident element concerned and the temporal sequence. The major accident elements are as follows: the driver, the vehicle, the social context (encompassing factors such as laws and regulations, general driving patterns, trip purposes, vehicle occupants, etc.), the ambience, the highway/environment, and traffic. The time sequence distinguishes the long-term factors, current condition, and the elements of the driving cycle. This driving cycle is a sequential arrangement of activities which (in reality) overlap to a large extent and may change continuously,

sion. Then the driver performs actions to which the vehicle responds. According to this response and the highway conditions, the vehicle moves, creating a new traffic configuration. If this situation is not an accident, a new cycle starts. There are two types of causal sequences in this network, those which describe the "normal" events when driving, and those which cause "failures" which may lead to crashes. The normal driving cycle is extremely complex, and the possibilities too numerous to be represented in a useful fashion. Therefore, this study was essentially limited to the causal sequences which lead to failures. Fifteen detailed networks, each describing the causal chain leading to failures in a specific part of the network, are presented. An even finer breakdown of causal and other factors is given in an extensive list, containing a coding scheme which, for example, would allow one to computerize a given network. The construction of the causal network revealed gaps in information on causative factors and interactions, in particular the driver's perception and decision-making processes. A review of the literature on accident causation was the basis for this study.

by Hans C. Jokschi; Joseph C. Reidy, Jr.; John T. Ball  
Center for the Environment and Man, Inc., 275 Windsor St.,  
Hartford, Conn. 06120  
Contract DOT-HS-6-01506  
Rept. No. CEM-4206-583; 1977; 124p 8 refs  
Rept. for Mar-Jul 1977. Vol. 2 is HS-802 592.  
Availability: NTIS

HS-802 592

### CONSTRUCTION OF A COMPREHENSIVE CAUSAL NETWORK. VOL. 2: LITERATURE REVIEW AND BIBLIOGRAPHIES

The literature on accident causation was reviewed to identify empirical and hypothetical causal relations. Conceptual studies are reviewed which develop accident causation structures of a network type. The basic structure common to all is a sequence in which the driver has to perceive a situation, make a decision, and take an action which leads to either an accident or to a new situation. The major studies of empirical causation are from the Inst. for Res. in Public Safety and from Calspan; the former uses detailed hierarchies of causal definitions, whereas the latter takes a more comprehensive view. Other studies reviewed deal with driver actions, biographical factors, social adjustment factors, driver record, alcohol and drugs, equipment failures, speed, and highway type and geometry. The 70 studies reviewed are tabulated according to causal factors categorized as driver, vehicle, and highway/environment. The detailed reviews appended include for each item its bibliographic data, chapter headings, main topics, and titles of figures and tables. Both an annotated bibliography and a general bibliography are also appended.

by Hans C. Jokschi; Joseph C. Reidy, Jr.  
Center for the Environment and Man, Inc., 275 Windsor St.,  
Hartford, Conn. 06120; Highway Safety Res. Inst.  
Contract DOT-HS-6-01506  
Rept. No. CEM-4206-583b; 1977; 142p refs  
Rept. for Phase 2, Nov 1976-Jul 1977. Subcontracted in part to Hwy. Safety Res. Inst. Vol. 1 is HS-802 591.  
Availability: NTIS



HS-802 595

# **STATUS OF THE HIGHWAY SAFETY PROGRAM STANDARDS AS OF JANUARY 1977**

The 1966-1976 statistics of the Highway Safety Program Standards as implemented by the states are summarized and concurrent Motor Vehicle Death Rate data are provided. The standards implementation statistics are based on reports furnished by the states, territories, and the District of Columbia; American Samoa, Virgin Islands, and Guam began reporting in 1974. Although Standards No. 17, Pupil Transportation Safety, and No. 18, Accident Investigation and Reporting, were incorporated into the Highway Safety Program in 1972, some sections of these standards were previously implemented by many states; this implementation is included. The statistics display a dramatic increase in the percentage of implementation and a steady decline in the death rate.

National Hwy. Traffic Safety Administration  
1977; 62p  
Availability: Corporate author

HS-802 607

# **FATAL ACCIDENT REPORTING SYSTEM. 1976 ANNUAL REPORT**

Statistics of the Fatal Accident Reporting System (FARS) computerized data base are arranged according to the following subjects: fatal traffic accident profile; non-occupant fatal traffic accident profile; single-vehicle fatal accident profile; multivehicle fatal accident profile; alcohol involvement; motor-cycle involvement; heavy truck involvement; vehicle mix; schoolbus fatal accidents; and fatality rates. Some data are compared with those for 1975. A total of 39,452 fatal motor vehicle traffic accidents reported to FARS from the 50 states and the District of Columbia in 1976; these accidents resulted in 45,181 fatalities. Data for fatal accidents in Puerto Rico are appended.

National Hwy. Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C. 20590  
Rept. No. AR-2; 1977; 129p  
Availability: Corporate author

HS-802 612

# **REPORT ON ADMINISTRATIVE ADJUDICATION OF TRAFFIC INFRACTIONS. HIGHWAY SAFETY ACT OF 1973 (SECTION 222) (THIRD ANNUAL REPORT)**

Two research and demonstration projects titled Special Adjudication for Enforcement (SAFE) were run by the National Hwy. Traffic Safety Administration in Washington during fiscal year 1973 and in Rhode Island during fiscal year 1974. The Washington project involved adjudication of traffic infractions by parajudicials; it was run by the Dept. of Motor Vehicles and the Seattle Municipal Court. The Rhode Island project involved the adjudication of traffic infractions by administrative hearing officers; it was run by the Dept. of Transportation. SAFE in both states freed the courts of a large traffic caseload and reduced the per case processing costs. The impact on the subsequent driving performance of offenders processed by the Seattle, Wash. SAFE was clearly as effective as the traditional court procedure. On the other hand, the even simpler bail forfeiture was also found to be least expensive

and almost as effective as either the magistrate or traditional system. It could not be determined whether either magistrate or driver analysts could improve the effectiveness of drive improvement programs by selecting the clients referred to these courses. The Seattle SAFE parajudicial model should be used as the standard for integration of judicial sanction decisions with driver licensing agency rehabilitation and license withdrawal decisions.

National Hwy. Traffic Safety Administration, Washington, D.C. 20590  
1977; 31p  
Availability: Corporate author

HS-802 630

# **RULES OF THE ROAD RATED**

State traffic laws are compared with the Uniform Vehicle Code (UVC) as of 1 Jan 1977, and are rated by their compliance to the Code. Numerical scores are assigned for compliance with each of the 13 articles in the "rules of the road" chapter of the code; data are tabulated. The traffic laws of Colorado, Delaware, and Pennsylvania were extensively revised in 1974. There are no substantial differences between the Uniform Vehicle Code and the traffic laws of five states: Georgia, Kansas, North Dakota, Pennsylvania, and Washington. Pennsylvania, which was ranked 50th and which had eight substantial differences, showed the most dramatic improvement in the decade by moving up to fifth in ranking with no substantial differences. The number of substantial differences between the UVC and state laws increased in Arizona, South Carolina, and Vermont. The number of substantial differences decreased, however, in 12 states and remained the same in 36 states.

by Edward F. Kearney  
National Com. on Uniform Traffic Laws and Ordinances  
Contract DOT-HS-5-01121  
Publ: Traffic Laws Commentary v6 n5 35p (Oct 1977)  
1977; 8refs  
Availability: GPO

HS-802 631

# **RECREATIONAL VEHICLE ACCIDENT INVESTIGATION STUDY. VOL. 1**

Analysis of 969 bi-level reported recreational vehicle accident investigations involving 981 recreational vehicles was made during the two-year period 1 Jan 1974-31 Dec 1975. Also included were 65 in-depth investigations of human, vehicular, and environmental factors involved in recreational vehicle accidents and determinations of recreational vehicle exposure and accident involvement rates and risk indices. It is concluded that recreational vehicles as a class are slightly higher risks, that vehicles pulling trailers are more likely to be involved in an accident than the recreational vehicle (RV) population at risk, that passenger cars pulling travel trailers are greatly overrepresented in accidents, and that the highest risk situation for a car/travel trailer combination involves highway speed, downhill curves, and wind from external sources. A comprehensive research program into the dynamics of the passenger vehicle/trailer combination is urged, and a study of human, vehicle, and environmental factors involved, with evaluation of remedies available at high RV accident locations. Thorough explanations should be provided in owner's manuals

safety measures, including reduction of the high fire risk of interior materials, prohibition of persons riding in trailers, periodic reexamination for driver's license renewal, and the requirement for improved fuel lines and for safety glass or polymer substitutes, are also recommended. The recent decrease in RV accidents (50% to 60% or more below originally projected totals for the RV accident study period), since 1973 may be ascribed to the energy crisis.

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University of Kentucky, Multidisciplinary Accident Study  
Team, Lexington, Ky. 40506  
Contract DOT-HS-201-3-766  
Rept. No. UK-766-Vol-1; 1977; 292p 124refs  
Availability: NTIS

HS-802 711

#### **A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL. NHTSA STAFF TECHNICAL REPORT**

by James C. Fell  
National Hwy. Traffic Safety Administration, National Center for Statistics and Analysis, 2100 2nd St., S.W., Washington, D.C. 20590  
1977; 25p 16refs  
Presented at American Assoc. for Automotive Medicine (21st) Conference, Vancouver, British Columbia, Canada, 15-17 Sep 1977. For abstract see HS-021 586.  
Availability: NTIS

HS-802 714

#### **ACCIDENT AND NEAR ACCIDENT CAUSATION: THE CONTRIBUTION OF AUTOMOBILE DESIGN CHARACTERISTICS. FINAL REPORT**

A study was conducted to determine the frequency and severity of driver/vehicle design mismatch problem contribution to accidents and near accidents, relate driver and vehicle characteristics to severity and frequency of problems experienced by drivers, develop and validate the method used to measure mismatch problems, and identify vehicle design countermeasures which would reduce problem frequency and severity. Based upon recommendations by experts literature reviews, focus panels and preliminary question testing, five direct mail questionnaires were developed and pilot-tested on a sample of 800 U.S. government employees. Results of the pilot study were analyzed and a single, modified questionnaire was recommended for a large scale survey of drivers. This questionnaire contained questions on vision, controls, steering, braking, shifting, and seating. Drivers were asked to respond to each question in terms of the degree to which a problem was experienced. Response categories included "no problem," "annoying," "potential danger," "close call," and "caused accident." Subsequently, a direct mail survey was conducted by three private institutions which surveyed 10,000 drivers from California and New Hampshire. The 3500 returns citing 1691 near accidents or accidents for various mismatch questions were analyzed by driver and vehicle demographic variables. The most frequent and severe problems experienced were vision related, e.g. oncoming headlight glare, window obscuration due to inclement weather, difficulty of gaining information from mirrors, and headlight glare on mirrors. Of the top 20 problems, 15 were vision related. Steering and braking

weight, sex, experience and exposure, vehicle age, size and model were uniquely related to specific mismatch problems experienced. Driver/vehicle mismatch problems are contributors to at least 7.5% of all accidents, or about 1.7 million accidents per year. Arguments are presented which suggest that this computed value may well be a gross underestimate.

by William J. Burger; Russell L. Smith; John E. Queen;  
Graham B. Slack  
Dunlap and Associates, Inc., Western Div., 7765 Girard Ave.,  
LaJolla, Calif. 92037  
Contract DOT-HS-5-01216  
1977; 211p 18refs  
Rept. for 19 Jun 1976-28 Feb 1977.  
Availability: NTIS

HS-802 760

#### **MOTOR VEHICLE DIAGNOSTIC INSPECTION DEMONSTRATION PROGRAM. SUMMARY REPORT**

In response to Title III of the Motor Vehicle Information and Cost Savings Act, PL-92-513, motor vehicle diagnostic demonstration programs were set up in Alabama, Tennessee, Arizona, Puerto Rico, and Washington, D.C. Treatment groups and pass/fail or control groups were compared. The diagnostic projects conducted more than 125,000 in-depth inspections over a 15-month period during 1975 and 1976. About 75% failed the initial inspection, with an average of 2.9 defects; brakes alone counted for 36% of initial failures. Operators of defective vehicles were requested to return for reinspection after repairs were made, so that repair bills and fuel consumption data could be gathered. Treatment groups and control groups spent about the same on repairs (average \$57.25) except in Tennessee and Washington, D.C. where treatment groups spent about \$21 more. This may have been the result of having no wheel removal for brake inspection in the control groups of those two locations. The treatment group spent more for brake repairs and less for emission-related repairs. The treatment group probably averted more costly repair bills in the future. The more detailed the information on defects given to the consumer, the lower the costs of repairs and the better the quality of repairs. Analysis of emissions data showed an overall average decrease of 22% for hydrocarbons and 12% for carbon monoxide. There was a 4.7% improvement in fuel economy immediately after performance of repairs to correct emissions. Consumer reaction to the program was positive. Reinspection of repaired vehicles to detect inadequate repair service averaged about 30% failures during the first cycle and about 20% failures during the second cycle. A special study showed that about 24% of repairs were unnecessary and that 32 cents of every dollar spent on repairs was unnecessary; females tended to be more victimized than males. Reject levels resulting from the Vehicle In Use (VIU) Standards were considered feasible. As for efficiency of design of the inspection facility, a dual parallel lift configuration similar to that used in Alabama is most efficient. Uniformity in diagnostic inspection procedures, processes, standards, and test equipment is recommended. Instances of incompatibility between test equipment and vehicles included exhaust analyzers with catalytic-converter equipped vehicles and small or front-wheel vehicle instability on roller-operated machines. Brake subsystem inspection is inhibited by vehicle design more than is any other inspection task. Federal safety and emission standards have a

negligible effect on the time necessary to perform repairs in typical cases.

by Joseph J. Innes; Leslie E. Eder  
National Hwy. Traffic Safety Administration, Office of State  
Vehicle Programs  
Rept. No. NTS-31; 1977; 95p 22refs  
Availability: NTIS

HS-802 874

# **PUBLIC HEARING ON THE ELECTRIC AND HYBRID VEHICLE. TRANSCRIPT OF PROCEEDINGS, WASHINGTON, D.C., 14 JULY 1977**

Statements on the electric and hybrid vehicle were made by representatives of the following organizations: Electric Vehicle Associates (EVA), the Denver Electric Vehicle Council, General Motors Corp., Consumers Union, Minicars, Inc., Center for Auto Safety, Gesellschaft für Strassenverkehr GmbH (GES), Volkswagen, Chrysler Corp., General Services Administration (GSA), Dynamic Science, Inc., Electric Passenger Cars, Inc., Automobile Owners Action Council (AOAC), National Aeronautics and Space Administration (NASA), American Public Transit Assoc. (APTA), Warranty News, Insurance Inst. for Hwy. Safety, and Lead Industries Assoc., as well as by some private citizens. Consumers Union and Chrysler believed that all highway safety standards should apply to electric vehicles except Federal Motor Vehicle Safety Standards (FMVSS) Nos. 102, 124, and 301. Minicars, Inc. supported the need for substantial electric power plant research and development contracts, but advocated that the Dept. of Transportation handle development, integration, and technical monitoring, with power plant responsibility allotted to ERDA. Minicars, Inc., Chrysler, GSA, and the Center for Auto Safety opposed safety standard waivers for electric vehicles. Volkswagen believed that crash barrier test speeds should be lowered for electric vehicles. Chrysler recommended a lowered barrier test speed for bumpers on these vehicles and a modification of standards for brake system performance and side door strength. AOAC suggested that the most important questions involve the need for safety standards for electric and the extent to which the standards add to or detract from consumer acceptance. AOAC considered the goals of safety standards as identifying safety hazards and reducing their potential for injury, as promoting electric vehicle performance, and as contributing to overall vehicle economy. APTA suggested that National Hwy. Traffic Safety Administration regulations be relaxed or waived during the development period, but that those organizations connected with development consider the concept of following safety standards during the development program. Mr. Dow, a consulting engineer, recommended a three-wheeled vehicle. Independent testing agencies such as Underwriters' Lab. and SAE should be involved in forming guidelines for electric vehicle standards. European safety standards were developed by the Electro International Commission (IEC).

National Hwy. Traffic Safety Administration, Washington,  
D.C. 20590  
1977; 165p  
Availability: Gale-Federal Reporters, Inc., 444 N. Capitol St.,  
Washington, D.C. 20001

HS-802 889

# **A STUDY OF EQUIPMENT CALIBRATION FOR AN EXPERIMENTAL AUTOMOBILE INSPECTION PROJECT**

Calibration data of the following pieces of equipment were evaluated to determine if the methods and procedures followed were sufficient and what calibration scale would be best for each piece of test equipment: a Bear platform brake tester; Hofmann and Sun roller brake testers; Marquette, Hamilton Standard, and Sun engine analyzers; Beckman, Marquette, Sun, and Horiba emissions analyzers; Weaver and Hunter wheel alignment testers; and a Hunter headlight tester. The equipment is used by Proj. Auto/SEE, an experimental automobile inspection project in Chattanooga, Tenn. That project's Calibration and Maintenance Procedures Manual was used as a guide for calibration evaluation. There should be a weekly calibration schedule for the Marquette engine analyzer voltmeter and spark advance scales and a twice-weekly schedule for all other scales. A biweekly schedule would suffice for the Sun and Hamilton Standard engine analyzers. Twice-daily gas calibration of the Beckman, Marquette, and Sun emission analyzers and daily calibration of the Horiba analyzer is suggested. Weekly calibration is suggested for the Sun and Hofmann roller brake testers, as is a biweekly calibration of alignment testers and weekly calibration of headlight testers. Additional data for the construction of a control chart would be required to determine an acceptable calibration schedule for the Bear platform brake tester. Calibration data are appended.

by David L. Love  
University of Tennessee, Dept. of Mechanical and Aerospace  
Engineering, Knoxville, Tenn. 37916  
Contract DOT-HS-5-01041  
Rept. No. TC-76-031; 1976; 300p 19refs  
Availability: Microfiche only

HS-802 890

# **A DYNAMIC ANALYSIS OF THE BEAR PLATFORM BRAKE TESTER**

The importance of brake condition to occupant safety and of the responsibility involved in undertaking a brake inspection program emphasize the need to understand the performance and reliability of the diagnostic equipment. In Project Auto/SEE in Chattanooga, Tenn., sponsored by the Federal government, the performance of the Bear Model 47-105 platform brake tester in large-scale brake inspections was determined by developing a mathematical model of the platform tester, the parameters for which were obtained from static and dynamic tests, measurements, and experimental data. This model was used as a tool for predicting the performance of the tester and for analyzing its effectiveness as a diagnostic instrument. Recommendations were made for modifications to the tester to improve its performance, such as assuring the operation of the linkage damper during the entire movement of the linkage, ensuring that no spacing exists between the gage tower piston knife edge and the linkage after the machine is zeroed, and removing the soft springs used for calibration. Further analysis of the tester after modification is recommended, as is evaluating the best method of adjusting the machine calibration. The best method may vary with each tester application. With these modifications, the tester was

found to be an accurate diagnostic tool for predicting brake performance.

by Joseph N. Herndon  
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Tenn. 37916  
Contract DOT-HS-5-01041  
Rept. No. TC-77-014; 1977; 132p 21refs  
Availability: Microfiche only

HS-803 036

## THE EVALUATION OF HIGHWAY TRAFFIC SAFETY PROGRAMS. A MANUAL FOR MANAGERS

The manual describes in nontechnical terms the concepts, methods, and techniques of evaluation of highway traffic safety programs, and demonstrates step-by-step, various procedures for conducting such evaluations. It suggests ways of organizing and managing a highway traffic safety project evaluation. Three principal types of social program evaluation are applicable to these projects: administrative, effectiveness, and efficiency evaluation. Similarly, there are three levels of evaluation which determine the precision and applicability of the information received: personal, clinical, and scientific evaluation. Steps in the evaluation process are outlined, as well as the tasks and activities which make up each step. Case illustrations are provided from real-world studies, emphasizing one or more aspects of the evaluation process.

by Judith M. Davis; Ralph M. Jones; William C. Kimberling  
Indiana Univ., Inst. for Res. in Public Safety, 400 E. Seventh  
St., Bloomington, Ind. 47401  
Contract DOT-HS-4-00883  
1975; 365p refs  
Availability: Reference copy only

HS-803 037

## CONSUMER INFORMATION CRASH TEST PROGRAM PREDICTION OF DYNAMIC CRASH RESPONSES FOR VEHICLE AND OCCUPANTS. FINAL TECHNICAL REPORT, VOL. 1

A total of 22 full-scale crash tests were conducted of 1973 and 1974 Ford Torinos and Plymouth Satellites as part of a program to test intermediate-size vehicles for damage susceptibility, crashworthiness, and repairability and to demonstrate the capability of existing simulation models for predicting the dynamic responses of the vehicles and occupants. The 1973 vehicles were tested by 15 mph and 30 mph collisions against a fixed, rigid barrier, 20 mph car-to-car, front-to-side, and front-to-rear impacts, and 15 mph rear impacts by a moving, rigid barrier. The 1974 models were tested by 8 mph, 25 mph, 30 mph and 35 mph collisions with the rigid barrier and front-to-rear impacts, and 15 mph rear impacts by a moving, rigid barrier. The 1974 models were tested by 8 mph, 25 mph, 30 mph, and 35 mph collisions with the rigid barrier and front-to-rear impacts of cars of the same make in which the rear of the stationary target vehicle was struck by the other car at speeds of 10 mph and 20 mph. Two 50th percentile male anthropomorphic dummies occupied each vehicle. Instrumentation included accelerometers, load cells, transducers, triaxial accelerometers, and high-speed cameras. Measurements were made of impact accelerations, longitudinal forces exerted on the face of the barrier during crushing of the vehicle forward structure in the fixed barrier tests, loads developed in the belts

of type 2 restraint systems, accelerations of dummy head and chest, and dummy femur force. Also measured were permanent crush of the vehicle structure and the vehicle damage index rating. Estimates of repair costs were obtained. Procedures for testing of vehicle interior components should be modified to obtain better data for input to the computer program. Refined values of some of the model input parameters for the test dummies are needed, based on experiments and exploratory simulations. Consideration should be given to modifying the restraint belt algorithm to eliminate the present limitation to either zero or infinite friction between the belts and the occupant. The 5 mph increment between the speeds of the 1974 tests appears to be too fine to produce significant differences in test results. Perhaps the third test should be used as a repeat of one of the two previous tests. Appended are the following data: static force-deflection data; Bashism model results for 30 mph frontal barrier impact; sample inputs to 3D occupant response model; and normal mean standard error of predicted passenger compartment acceleration for frontal barrier tests.

by N. E. Shoemaker; M. O. Ryder; N. J. DeLeys  
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221  
Contract DOT-HS-4-00910  
Rept. No. ZT-5561-V-26; 1975; 240p 12refs  
Availability: NTIS

HS-803 038

## DESCRIPTION OF THE DIAGNOSTIC AUTO INSPECTION LANE. TECHNICAL PUBLICATION

The District of Columbia (D.C.) Dept. of Motor Vehicles operates a diagnostic inspection lane at its Southwest Inspection Station as part of a demonstration project of PL-92-513, the Motor Vehicle Information and Cost Savings Act. The first of five stations in the lane contains the cathode ray tube and keyboard for computer interface to enter vehicle identification number, license number, description, and registration date, a tire pressure gauge and inflator, and another computer interface device to enter reject/advisory pass/pass information into the computer. The second station contains an emissions tester, a roller type brake analyzer and dynamometer, a computerized brake system analyzer, an engine analyzer, a headlight tester, and a computer interface device. The third station contains a scuff tester for wheel alignment, a twin post lift for under-chassis inspection and for wheel removal and brake examination, and a computer interface device. The fourth station contains a wheel alignment test system and a computer interface device. The fifth station contains a platform brake tester, a computer interface device, and an output printer. An AVCO System 210 minicomputer is used. Inspection data from the computer disc file are transmitted by telephone line to a central IBM 370 computer for filing on magnetic tape and subsequent analysis; copies of the manually prepared inspection forms are card punched and entered into the central computer file. In addition, the inspector who has accompanied the vehicle through the lane describes the results of the inspection to the vehicle owner, explaining cause of rejection if any and advising as to which systems need repairs and which are in good condition. All inspections and tests performed are listed, with the purpose of each and the criteria by which to reject or to advise pass.

District of Columbia, Office of Vehicle Safety Res.  
Contract DOT-HS-354-3-716  
1975; 89p 7refs  
Availability: Reference copy only

HS-803 057

HS-803 057

## SPECIAL REPORT ON OSTEOLOGIC STUDIES

A loading device was fabricated to load, measure, and record the force-deflection characteristics of the sixth or seventh rib, taken between the anatomical midclavicular and posterior axillary line, during a loading to fracture autopsy test. In addition, various photographic schemes were investigated in an effort to obtain the optimum visualization of the cortical cross sections of the ribs. The rib section should be cleaned prior to photographing; ultraviolet light is not necessary if red marrow is removed; but if such light is used, the reflected light should be filtered out at the camera lens. While the rib test appears to allow classification of some skeletal conditions in cadavers, it is a postmortem classification. The use of an easily obtainable long bone, one that can be removed and tested prior to a cadaver acceptance as a Calman and at the same time not adversely affect the proposed test, such as a radius for this classification could aid in selection of a restraint system to be tested with a particular cadaver. It is recognized that an osteoporotic cadaver, for example, will be much more sensitive to a hard deceleration pulse in a stiff belt system than to an inflatable restraint system with the same pulse. However, the cadaver should not be rejected simply because of the level of osteoporosis since other valuable data such as gross kinematics, head angular acceleration, thoracic cage kinematics, arterial and lung pressures, and chest deflections can be obtained from the subject if the proper restraint system is used.

by Michael J. Walsh  
Calspan Corp.  
Contract DOT-HS-5-01017  
Rept. No. ZM-5763-V-8; 1976; 27p  
Task order no. 4.  
Availability: Reference copy only

HS-803 107

## TRAFFIC SPEED LIMIT LAWS IN THE UNITED STATES

State laws which regulate vehicle speed in the context of comparable provisions of the Uniform Vehicle Code are reviewed. Included in the discussion are the basic speed rule, statutory maximum speed limits, minimum speed regulations, and the authority of officials to establish limits through speed zoning. Additionally covered is implementation of the 55 mph speed limit in the state laws. This review concerns state laws in effect as of 1 Jan 1977. The concept of prima facie speed limits has proven to be inadequate for the needs of modern traffic control. The offense under the law is one of driving at a rate of speed greater than is prudent and reasonable, rather than driving in excess of the posted speed limit. Adoption of absolute rather than prima facie speed limits is recommended. The 55 mph speed limit should be treated as a permanent limit in every state. Conflicting limits which are now only superseded should be repealed, and the 55 mph limit should be enacted as the statewide statutory vehicle code limit. Laws which abrogate the sanctions for violating that limit should be repealed. Statutory limits should be kept simple, perhaps by having only one for urban areas and one for other areas. The National Com. on Uniform Traffic Laws and Ordinances

HSL 78-05

recommends one speed limit for all types of traffic in the stream.

by John W. English; Steven H. Levin  
National Com. on Uniform Traffic Laws and Ordinances  
Contract DOT-HS-5-01121  
Publ: Traffic Laws Commentary v7 n1 (Jan 1978)  
1978; 124p refs  
Availability: GPO Stock No. 050-003-00300-0

HS-803 122.

## RSV [RESEARCH SAFETY VEHICLE] PHASE 3. INTERIM PROGRESS REPORT NO. 3, OCTOBER 1977

The contractor was directed to consider adding a crush beam to the rear end, stretched acrylics for glazing of side and rear windows, and to add the additional tasks of constructing an operational large research safety vehicle (RSV) and sled testing of the air cushion restraint system (ACRS) to study out-of-position occupant protection. The first sled tests of the driver's restraint system using the Phase 3 column design were made. System components of the passenger restraint system were mounted. Additional tooling aids were requested from the subcontractor. The original 30° tilt angle of the Honda engine will have to be retained. Padding materials selection for side doors and headers was completed. Maximum outside dimension of the two antennas was determined to be 31 inches. The radome material will be a polyester resin-filled fiberglass. Consultant help was sought on algorithms for RCA's cruise control; changes are detailed. A modified brake pillar has been designed. Handling tests are in preparation. Compatibility analyses will include tests of individual load paths in a forthcoming side crush test. Modifications were made to the stock Honda manual transmission to reduce the shifting effort, and an electrical shift actuator was installed. Work continued on the computer simulation model of estimation of vehicle performance. An algorithm has been developed for automatic control of manual transmission. As for benefit/cost methodology, work on the KRAESP model focused on validation. An updated Multidisciplinary Accident Investigation (MDAI) file has been received. The front and rear dynamic systems of the large RSV have been spatially aligned with respect to the body compartment. A procedure for determining its tire rolling resistance and aerodynamic drag from vehicle coastdown tests was developed. Analysis of the Impala coastdown data indicate a drag coefficient of 0.53 plus or minus 0.03. A butyl base adhesive, PARLASTIC, is recommended for RSV glazing. Orders were placed for windshield tooling and windshields. Epoxy casts for parts of the upper body plug have been received.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017  
Contract DOT-HS-7-01552  
Rept. No. PR-3; 1977; 12p  
Availability: Reference copy only

HS-803 123

## RSV [RESEARCH SAFETY VEHICLE] PHASE 3. PROGRESS REPORT, AUGUST/SEPTEMBER 1977

Preparation for Oct 1977 sled tests included completion of the research safety vehicle (RSV) sled buck, refinements to the driver restraint system, and generation of a tentative test matrix. The passenger restraint system has been extensively

modified in Phase 3 to make it lighter and easier to fabricate. System performance is to be evaluated by sled test. An analysis was conducted to obtain an airbag inflator system with less inflation energy than the Phase 2 inflator, in order to meet energy criteria for out-of-position passengers. A chart of the weight breakdown by system shows significant changes from Phase 2, including cooling system (increased), propulsion and rear suspension (decreased), steering and front suspension (increased), and body glazing (increased). The redesign of latch and lock hardware has been completed, resulting in a 30 lb increase in door weight. Status of system refinement tasks is tabulated. Design of most systems is complete. An evaluation mockup of the restyled notchback configuration on the RSV design is expected to reduce weight by 30 lbs, at a cost in luggage space, increase in drag, and reduced peripheral driver vision. The possibility of a plastic lower door has been studied. Acceptance criteria were established for reaction injection molding (RIM) body glove parts. Results of dynamic tests on side door padding are tabulated. Work on interior padding has been completed. RCA's work on the electronic subsystem is reported, including a table comparing the collision mitigation system and a graph of braking performance. Instrumentation work for ride and handling test has been initiated. The first nine static crush tests have been conducted; graphs are presented from tests ST6 and ST9. Progress reports on the automation of a manual transmission are presented. Dynamometer tests on the turbocharged Honda Accord engine were continued. Power output is tabulated at various speeds and throttle settings. The eight Build V body structures are all complete to the level of available fabrication drawings. Vehicles M4-2, M4-3, and M4-4 have had major systems installed, the last two lacking only restraint systems to be ready for testing. Accident benefit analysis is presented. The Chevrolet Impala was selected as the baseline vehicle for the large RSV (LRSV), and the Lancia-Beta front wheel drive five-speed transmission. Preliminary weight estimates by system for the LRSV are tabulated. Preliminary tests were performed on the current glazing retention-emergency egress configuration. A preliminary manufacturing schedule was developed. The Minicar, Inc. "Employee Safety Handbook" is included. A list of suppliers is presented who were contacted for information on sheet metal, glazing, RIM, and sealants.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017  
Contract DOT-HS-7-01552  
Rept. No. PR-Aug/Sep-1977; 1977  
Bimonthly rept. Appendices include: Minicars' RSV Passenger Restraint System Analysis for Out-of-position Occupants; RCA Labs. Progress reports 6 and 7 (Aug/Sep) on Electronics for RSV; University of Utah Progress reports, Aug/Sep, on Collision Mitigation System and Headway Control Function; Dubner Computer Systems, Inc., Progress reports, Aug/Sep, on Automation of Manual Transmission; and Kinetic Research, Inc. Progress report on their Accident Environment Simulation and Projection model.  
Availability: Reference copy only

the police department, traffic courts, hospitals, and other treatment centers. Its catalytic effects included increased interest and activity in arrests for driving while intoxicated, and requests for public information and education outside the ASAP area. The activities of the enforcement, judicial, rehabilitation, and public information and education aspects of ASAP are reviewed. Expenditures for 1976 and for the project as a whole were less than estimated.

by Allen C. Weiss  
New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130  
Contract DOT-HS-059-1-076  
1977; 14p  
Availability: NTIS

HS-803 125

#### NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT

The New Orleans, La., Alcohol Safety Action Proj. (ASAP) cannot be shown to have reduced the number of fatal accidents but did have some impact on reduction of traffic accidents in general. The shift from citywide patrolling to saturation patrolling as an enforcement technique did not have any measurable impact on arrests and accidents. Although in some areas arrests increased and accidents decreased, certain variables such as increased police time on the streets preclude any assumption that these factors were due to ASAP's presence. The special ASAP patrols had higher arrest rates than regular patrols; the persons so arrested had lower blood alcohol contents (BAC's), and tended to be more compliant about taking breath tests. Although ASAP resulted in a threefold increase in drunk-driving arrests, the anticipated case backlog in Traffic Court never materialized. The BAC was the most important single factor in determining guilt or innocence of the driving while intoxicated (DWI) charge. Disposition of cases varied from year to year; it did not appear to matter who was prosecuting the case as to its outcome. The different treatment modalities were suitably altered to the needs of each client within established treatment programs. The assignment of clients to treatment programs based on findings of the presence investigations limited the ability to analyze successfully the effectiveness of the various programs. A Short Term Rehabilitation study has been initiated following ASAP's continuation which showed that the number of recidivists did not differ significantly from one treatment mode to another. No specific data were gathered on any ASAP activities by which firm evaluations could be made. Telephone, household, and roadside surveys indicated, however, that although there was an increasing awareness of ASAP, little change in attitudes or behavior could be ascribed to the publication information and education effort.

by Allen C. Weiss; Antoine A. Laiche, Jr.  
New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130  
Contract DOT-HS-059-1-076  
Rept. No. ASAP-Final-report-1977; 1977; 125p  
Availability: NTIS

HS-803 124

#### NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT. TECHNICAL SUMMARY

The New Orleans, La., Alcohol Safety Action Proj. (ASAP) began operation in Jan 1972 and terminated in Dec 1976. New Orleans was chosen because of its tolerance of drinking, its high rate (77%) of alcohol involvement in traffic fatalities, and the failure of earlier campaigns to curb drunk driving. The project was based on Federal funding and on cooperation among

Data on the New Orleans, La., Alcohol Safety Action Proj. (ASAP) for 1976 are presented on a quarterly basis under the following headings: total project impact on both fatal and injury-producing crashes involving single vehicles, multiple vehicles, and pedestrians; blood alcohol concentration (BAC) data for drivers killed and for drivers arrested for alcohol-related offenses; enforcement patrols both regular and ASAP; judicial disposition of alcohol-related traffic arrests and background investigation activity; rehabilitation status report; diagnosis and review activities; driver license record review; summary of public information and education activities; and financial and personnel data for the various programs.

by C. J. Hebert; John Duffy  
New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130; Louisiana Computing Corp., 3444 Olympic Drive, Metairie, La. 70003  
Contract DOT-HS-059-1-076  
Rept. No. ASAP-Final-report-1977-App-H; 1977; 114p  
Availability: NTIS

HS-803 127

#### **NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. TOTAL PROJECT IMPACT**

The impact of the New Orleans, La., Alcohol Safety Action Proj. (ASAP) on the overall accident rate in New Orleans was studied by multiple regression analysis of accident data using interrupts for ASAP and other significant events in the New Orleans area. ASAP was shown to have had no impact on traffic accidents. A similar analysis that was based on collision theory model showed that ASAP had a significant impact on accidents, especially on daytime accidents. The finding was contrary to expectations since ASAP enforcement patrols operated at night. The magnitude of the effects, however, was not nearly as impressive as originally anticipated. An analysis of fatal accidents showed no impact due to ASAP. It should be remembered that any program aimed at the drunk driver would have impacted only about 25% of the fatal accidents or about two accidents per month, since nearly 50% of the traffic fatalities are pedestrians or bicycle riders and about 50% of motorists in fatal accidents had been drinking. The goal of reducing the number of fatal accidents in New Orleans was an unrealistic one. ASAP patrols arrested more persons for driving while intoxicated than did the regular patrols, and at lower blood alcohol concentrations (BAC's).

by John Duffy; Clifford J. Hebert  
New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130; Data Industries, Inc., 3444 Olympic Drive, Metairie, La. 70003  
Contract DOT-HS-059-1-076  
Rept. No. NOASAP-Analytical-study-1-1977; 1977; 69p  
Subcontracted to Data Industries, Inc.  
Availability: NTIS

The New Orleans, La., Alcohol Safety Action Proj. (ASAP) used a special patrol for enforcement known as the Alcohol Safety Enforcement Section (ASES). The patrol operated from 9 P.M. to 5 A.M. Tuesday through Saturday nights. During the continuation phase of ASAP in 1975 and 1976, patrols were arranged according to the saturation technique. Arrests in some areas increased and accidents decreased. There was no evidence that saturation patrols caused a substantial decrease in the number of drinking drivers within the area since the decrease in accidents in the selective enforcement patrol areas was accompanied by an increase in the amount of time the police were on the street as well as an increase in the number of arrests. The change in accident rates during the selective enforcement period cannot be ascribed to either of these variables. The ASES patrols arrested drunk drivers whose blood alcohol content was lower than individuals arrested by regular patrols. Although there was no drying-up effect seen in the analysis of the saturation patrolling experiment, there is evidence that the average BAC of drunk drivers arrested in New Orleans has declined during the ASAP period.

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Contract DOT-HS-059-1-076  
Rept. No. NOASAP-Analytical-study-3-1977; 1977; 40p  
Subcontracted to Data Industries, Inc.  
Availability: NTIS

HS-803 129

#### **NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. JUDICIAL**

In order to accommodate the threefold increase in arrests for driving while intoxicated (DWI) by the New Orleans, La., Alcohol Safety Action Proj. (ASAP) patrols, two part-time special prosecutors were provided whose sole responsibility was prosecution of DWI's. A stepwise multiple discriminate analysis was used to determine which factors of those available were important in determining whether a driver was found not guilty, guilty of a reduced charge, or guilty of the original DWI charge. In addition, a group composed of individuals who did not appear for their court hearing and who are still at large was included. The most important determinate was shown to be the blood alcohol content (BAC) of the individual as measured at the time of arrest. There have also been large year-to-year variations in the disposition of cases. The individual prosecuting the case did not seem to affect significantly the disposition.

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Contract DOT-HS-059-1-076  
Rept. No. NOASAP-Analytical-study-4-1977; 1977; 29p  
Subcontracted to Data Industries, Inc.  
Availability: NTIS

they were assigned to treatment groups on a random basis in order to judge the effectiveness of the various types of treatment. The types of treatment used were group therapy, power motivation training, Antabuse therapy, and Alcohol Safety Action School (ASAS) in various combinations with probation, as well as probation alone. There were no differences between the various types of treatment other than the ones which could have been predicted from the initial data. Conclusions are as yet tentative since the study is still in operation.

by John Duffy; C. J. Hebert  
New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130; Data Industries, Inc., 3444 Olympic Drive, Metairie, La. 70003  
Contract DOT-HS-059-1-076  
Rept. No. NOASAP-Analytic-study-5/6-1977; 1977; 65p  
Subcontracted to Data Industries, Inc.  
Availability: NTIS

HS-803 131

#### **NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. PUBLIC INFORMATION AND EDUCATION**

The New Orleans, La., Alcohol Safety Action Proj. (ASAP) attempted to educate the public concerning the ASAP program and the facts of drunk driving. Methods used included newsletters, brochures, mailings, drinking dials to determine blood alcohol content, and imprinted litter bags, napkins, and bumper stickers. Individual breath testing devices called alcolysers were demonstrated, and a mobile van with breath testing equipment was set up in the French Quarter for voluntary use. News coverage and public service announcements were helpful. The speakers' bureau arranged for hundreds of lectures, some of which included use of films. A youth program included speakers, teacher workshops, and establishment of a Mayor's Action Council of Youth. A special campaign was made to increase the fear of arrest if driving while drunk. Evaluation of the public information and education efforts was made by telephone, household, and roadside surveys. The surveys showed little change in overall attitudes, although awareness of the ASAP program increased.

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New Orleans Alcohol Safety Action Proj., 545 St. Charles Ave., Room 302, New Orleans, La. 70130; Data Industries, Inc., 3444 Olympic Drive, Metairie, La. 70003  
Contract DOT-HS-059-1-076  
Rept. No. NOASAP-Analytic-study-7-1977; 1977  
Subcontracted to Data Industries, Inc.  
Availability: NTIS

Rd., San Antonio, Tex. 78284  
Contract DOT-HS-049-1-065  
1977; 27p

Subcontracted to Southwest Res. Inst. For abstract see Project Director's Report, HS-803 138.  
Availability: NTIS

HS-803 133

#### **SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF OVERALL PROJECT IMPACT, 1975-1976**

The San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) was in operation for an initial three-year period (1972-1974) and for a two-year continuation period (1975-1976). During the initial period, the key percentage of surveyed drivers who were driving while intoxicated (DWI) dropped from 12.9% in 1971, to 10.7% during the first two ASAP years, and then moved upward to 11.8% in 1974. Over half the drivers surveyed from 1 A.M. to 3 A.M. on Friday and Saturday nights had been drinking, and about one-fifth were driving while intoxicated. Prior to the continuation period, the limited enforcement effort (5000-6000 DWI's arrested per year) and limited rehabilitation programs (2000-3000 clients per year) could not possibly have a significant impact on the accident patterns for the entire city. Traffic accidents in San Antonio have steadily increased over many years. Statistical analysis showed a significant difference between pre-ASAP and ASAP accident trends, with injury accident trends increasing and property accident trends decreasing during the ASAP period. These results were independent of the establishment of the mandatory 55 mph maximum speed limit. Fatal accidents showed a slight overall decrease, with the number occurring between 8:00 P.M. and 4:00 A.M. falling below pre-ASAP levels in 1976. There was a significant increase in the degree of drinking between the baseline and operational periods; however, the increase in percent DWI over the six years evaluated was not statistically significant. There was no significant decrease in the percentage killed that were DWI. Impaired or drunk drivers were responsible for more accidents during 1975 and 1976 than in previous years. During the ASAP period, six significant factors, over which ASAP had no control, influenced the impact which ASAP had on traffic safety in San Antonio: population increases, climatic conditions, the fuel shortage, road construction, economic conditions, and teenage drinking. Of these six factors, only one change was favorable to a decrease in traffic accidents. Step-wise regression analyses were used to determine the possible extent to which the five unfavorable factors adversely impacted accident patterns in San Antonio. There was a distinct possibility that they combined to overwhelm the positive effects of ASAP. The San Antonio/Bexar County DWI control system resulting from the five-year ASAP effort provides a continuation of major ASAP countermeasures integrated into existing city and county agencies. System activities should result in overall annual net revenues of approximately \$185,000. With appropriate revenue-sharing arrangements between the city and county, the system could operate as a completely locally funded pro-



HS-803 134

gram. While ASAP did not provide conclusive evidence that it decreased traffic fatalities and injuries, the program did provide greatly improved services to DWI offenders and the community at large.

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Contract DOT-HS-049-1-065  
Rept. No. ASAP-Analytic-study-1-2-1977; 1977; 27p  
Subcontracted to Southwest Res. Inst.  
Availability: NTIS

HS-803 134

# **SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF SELECTIVE ENFORCEMENT, 1975-1976**

Selective enforcement activities for the 1975-1976 continuation period of the San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) were implemented in five areas: training of additional officers, evaluation patrols on weekend nights on selected sections of the expressway system, evaluation patrols on all nights in two city evaluation areas, citywide roving patrols on all nights of the week, and saturation patrols on all nights of the week in four segments of the expressway system. The criteria used for selection were appropriate for locating highly motivated officers, and the training was effective in increasing the arrest rate of these officers. However, continuous monitoring was required to sustain the high level of driving while intoxicated (DWI) arrest productivity, even for highly trained and motivated personnel. The use of CB radios to apprehend DWI offenders is not cost-effective in urban areas of high traffic density. Total allocable costs for the enforcement effort during 1975-1976 were \$600,000 and total revenues generated were \$968,000, resulting in a net revenue per DWI of approximately \$56. This net revenue from enforcement activities was nearly sufficient to offset Federal and local matching funds expended for project management, the problem drinker evaluation center, and public information and education. With minor policy changes, the City of San Antonio and the County of Bexar could together develop a financially self-sufficient DWI control system. As for selective enforcement evaluation patrols, a force level of four to six units in a seven square mile area was marginally effective in reducing accidents but did not have a positive impact as measured by the other parameters. The four to six unit level of enforcement in a 37 square mile area was insufficient to produce a deterring effect on abusive drinking-driving or on street crime. The analysis of weekend expressway patrol activities indicated that the patrol level applied was marginally effective in reducing fatal and injury accidents. However, it did not impact the percentage of DWI's. During the last six months of 1976, all ASAP patrol efforts were concentrated on patrolling four expressway segments totaling 24.4 miles in length. The presence of additional units during all nights of the week had a significant impact on the number and severity of accidents, particularly on those segments of from four to six miles in length. The early and continued support of police officials is essential to the success of the enforcement countermeasure and all other ASAP activities. Special police training in identifying, apprehending, and processing DWI's is a major factor in increasing the number and quality of arrests. The use of special overtime forces at a sustained level is effective in increasing the number of DWI arrests. In order to maintain an effective enforcement countermeasure, ASAP must provide for increased cooperation

between police departments and the courts. In order to be effective over the long term, the enforcement program must be tailored to local conditions and must reflect local support.

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Contract DOT-HS-049-1-065  
Rept. No. ASAP-Analytic-study-3-1977; 1977; 24p  
Subcontracted to Southwest Res. Inst.  
Availability: NTIS

HS-803 135

# **SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF ADJUDICATION, 1975-1976**

Adjudication activities for the 1975-1976 continuation period of the San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) involved processing of driving while intoxicated (DWI) cases by the Bexar County District Attorney as a reduction in charge to public intoxication after successful completion of a prescribed course of ASAP instruction, and by the Bexar County Courts-At-Law on the original DWI charge. In addition, the District Attorney and four of the five Courts-At-Law participated from Apr 1975 to Mar 1976 in a research experiment to permit a valid assessment of the effectiveness of the ASAP-sponsored rehabilitation modalities. The research design required the random assignment of clients into treatment-no treatment groups as determined to be appropriate by the Problem Drinker Evaluation Center operated by ASAP. Total dispositions and the outcomes for the continuation period followed the patterns of the initial ASAP years. Between 75% to 80% of the outcomes resulted in probation for a DWI conviction or a reduced charge conviction; both of these results provided an opportunity for ASAP diagnosis, referral, and rehabilitation. The rejected-dismissed outcome remained at about 13%, which was considered high, but it was primarily the result of plea-bargaining on multiple charges. The judicial system was effective in handling the workload generated by ASAP. The District Attorney, while using charge reduction as a mechanism to help control backlog, wholeheartedly supported the ASAP concept by referral of 75% of the reduced charges to an ASAP rehabilitation modality. Analysis of the degree to which the judicial system cooperated in the random assignments required by the research design indicated an overall compliance of 95%. The scientific evaluation of adjudication, which was based on a detailed analysis of a sample of 100 DWI's arrested in January of each year, confirmed the previous findings that the judicial system made extensive use of the ASAP concepts during the continuation period; over 60% were referred to the Problem Drinker Evaluation Center, and over 55% referred to an ASAP rehabilitation modality. ASAP made an impact on the entire criminal justice philosophy: attention was shifted from trial to disposition system, from legal technicalities to case processing, from the individual judge to the concept of a court system, and from an isolated sentence to a team interaction between all legal and public health agents.

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Rd., San Antonio, Tex. 78284  
Contract DOT-HS-049-1-065  
Rept. No. ASAP-Analytic-study-4-1977; 1977; 18p  
Subcontracted to Southwest Res. Inst.  
Availability: NTIS

Problem Drinker Evaluation and Rehabilitation activities for the 1975-1976 continuation period of the San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) were implemented in five areas: diagnosis of degree of drinker problem and random assignment to appropriate treatment modalities or control groups by the Problem Drinker Evaluation Center; conduct of the Alcohol Instruction and Driver Education (AIDE) School for social drinkers by the Greater San Antonio Safety Council; conduct of multifaceted treatment programs for problem drinkers by the Alcohol Treatment Program, Bexar County Mental Health-Mental Retardation; conduct of Power Motivation Training for problem drinkers by counselors certified as instructors in that technique; and initial and followup Life Activities Inventories for problem drinkers randomly assigned into the Short-Term Rehabilitation Experiment. The research design called for equal numbers of clients to be recommended to treatment groups and to control groups. Attendance at, or completion of, the AIDE School had little or no impact on the probability of DWI recidivism. None of the dependent variables analyzed showed any changes over time which were different for subjects in the three different treatment groups. The analysis of recidivism by the Univ. of South Dakota indicated no differences among the three treatment groups. The initiation and operation of a problem drinker evaluation center is essential to the development of the diagnosis-referral-rehabilitation system established under the ASAP concept. The establishment of an AIDE school or similar rehabilitation measure for DWI offenders classified as social drinkers offers an opportunity to effect behavioral modification before the client's drinking becomes a more serious problem. However, care must be taken to avoid indiscriminately offering assignment to AIDE as a condition for reduced charges as schools of this type are not appropriate for borderline or problem drinkers. Treatment programs for borderline and problem drinkers are normally available within the community. The task of ASAP is to identify the treatment programs available and develop a system of referral between these programs and the adjudication system. Care must be taken to ensure that the adjudication and rehabilitation countermeasures have the capacity to effectively handle the increase in caseloads resulting from increased ASAP enforcement activities.

by Thomas E. Hawkins; Charles B. Dreyer; Charles S. Feldstone  
San Antonio Alcohol Safety Action Proj., 303 S. Alamo St., San Antonio, Tex. 78205; Southwest Res. Inst., 8500 Culebra Rd., San Antonio, Tex. 78284  
Contract DOT-HS-049-1-065  
Rept. No. ASAP-Analytic-study-5/6-1977; 1977; 34p  
Subcontracted to Southwest Res. Inst.  
Availability: NTIS

HS-803 137

# **SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF PUBLIC INFORMATION AND EDUCATION, 1975-1976**

Public information and education activities of the San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) were implemented in four areas: a national mass media effort aimed at

1975 and 1976. The national media campaign, which had its theme "Friends Don't Let Friends Drive Drunk," had little impact on the general public in the San Antonio area, due to the total reliance placed on public service messages, and the "macho" attitude which prevails among most of the population in San Antonio. The "Know Your Limit" campaign, which was used for five years, continued to make slow, but steady progress. The local "Fear of Arrest" campaign, designed and implemented in 1975 by a local advertising agency, was the most successful public information campaign in the five years of ASAP in San Antonio. The 1976 local "Fear of Arrest" campaign was intended to increase the perception of the selective enforcement forces saturating the expressways by drinking drivers who frequently used the expressway system at night. Driver awareness was shown to be due almost entirely to direct observation of patrol units; the limited media campaign, at best, served only to reinforce earlier direct observation. A pilot driver education program, embodying a three-hour block of instruction on alcohol and driving, was implemented in one school district. The program caused a statistically significant improvement in knowledge levels for the ASAP school district, but did not seem to deter subsequent driving while intoxicated (DWI), moving traffic violations and accidents. The most successful ASAP campaign is one which is tailored for local conditions or modified and amended to reflect local support.

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Contract DOT-HS-049-1-065  
Rept. No. ASAP-Analytic-study-7-1977; 1977; 17p  
Subcontracted to Southwest Res. Inst.  
Availability: NTIS

HS-803 138

# **SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. PROJECT DIRECTOR'S REPORT, 1975-1976**

The San Antonio, Tex., Alcohol Safety Action Proj. (ASAP) was initially funded for the three-year period 1972-1974 and later continued for the two-year period 1975-1976. Reviews are given of the project's administration and its activities in the areas of enforcement, judicial, problem drinker evaluation, rehabilitation, and public information and education. Plans for activities after ASAP termination are given, as is supplementary information on the economics of ASAP and use of ASAP results in other programs. An index of project reports is included.

by Kenneth F. Langland; Thomas E. Hawkins; Charles B. Dreyer  
San Antonio Alcohol Safety Action Proj., 303 S. Alamo St., San Antonio, Tex. 78205; Southwest Res. Inst., 8500 Culebra Rd., San Antonio, Tex. 78284  
Contract DOT-HS-049-1-065  
1977; 70p  
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Availability: NTIS

HS-803 139

# PERIPHERAL VISION TRAINING FOR MOTOR VEHICLE DRIVERS. FINAL REPORT

A study was undertaken to determine if the peripheral vision of motor vehicle drivers can be improved through training. The specific goals were as follows: to develop an indoor training technique which would produce substantial improvement in one or more peripheral vision functions, and to determine if the improvements realized through indoor training would transfer to both similar and different peripheral vision functions in the driving context. Three experiments were performed. Since peripheral vision declines with age, the majority of the subjects participating in these experiments were 60 years of age or older. During the first experiment the training regimen was too strenuous for the subjects so that no useful results, other than methodological ones, were obtained. The second experiment consisted of ten days of training on vehicular silhouette recognition in the peripheral field of view. The experimental subjects showed significant and substantial improvement in their ability to recognize vehicular silhouettes. A control group showed no improvement. The third experiment replicated the second one with the addition of testing while driving on the highway. A control group was administered the same tests as the experimental subjects. The experimental group again showed substantial improvement in peripheral vision performance in the training context. They also showed significant improvement on the silhouette recognition and motion detection tests conducted during driving. Remarkably, however, the control group exhibited nearly as much improvement on the same tests. The difference in improvement between the groups was not statistically significant; thus, there was no evidence that improvement of peripheral vision due to indoor training transfers to the driving context. However, the rapid improvement in peripheral vision performance during driving tests by both experimental and control subjects is testimony to the fact that this is a readily trainable function.

by Robert T. Hennessy; Robert E. Newton  
Human Factors Res., Inc., 6780 Cortona Drive, Goleta, Calif. 93017  
Contract DOT-HS-5-01204  
Rept. No. HFR-1767; 1977; 237p 71refs  
Rept. for 17 Jun 1975-28 Feb 1977.  
Availability: Reference copy only

HS-803 140

# RSV [RESEARCH SAFETY VEHICLE] PHASE 3. INTERIM PROGRESS REPORT, AUGUST 1977

Phase 3 of the research safety vehicle (RSV) project's schedules and cost budgets was revised to allow for a longer time span and for additional work. Work on the antiskid braking system was subcontracted to the Univ. of Utah. A sled test of the prototype A seat was invalidated due to a failed Volvo seat adjuster. Budd was directed by purchase order modification to construct the upper body plug; molds for all eight glazed areas have been received. Tilting of the engine at 10° instead of 30° has eliminated the need for the expensive oil galley modification. A sample of energy-absorbing plastic foam from USM Corp., Bailey Div., did not provide the desired flat-slope force deflection characteristic in dynamic tests. Work proceeded on radar headway control and on other electronic systems, as did work on the arrangement of various ITT-Teves brake system components. Static crush tests of the rear of the M4-1 vehicle and of the left side of the M4-9 vehicle were

made. Work on the Honda Accord turbocharged engine focused on carburetor development. Fabrication of spare part and soft alignment tooling for the M5 vehicle series was begun. The M4-3 and M4-4 test vehicles were completed. Work on design of a large RSV included disassembly of a 197 Chevrolet Impala and selection of the Lancia Beta transmission, transaxles, and front suspension for use with the advanced Volvo B21 engine. Securiflex is a candidate glazing for side door windows.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017  
Contract DOT-HS-7-01552  
Rept. No. PR-Aug-1977; 1977; 7p  
Availability: Reference copy only

HS-803 141

# NEW HAMPSHIRE ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT

The New Hampshire Alcohol Safety Action Proj. (ASAP) operated for a five-year period, 1972-1976, during which time the average annual total of fatal accidents in the state was 12% less than the comparable total for the five years before the project. Fatal accident totals during the ASAP period represent a departure from the trend in effect for a number of years prior to the project. Changes were in the subsets of accidents which were most likely to be alcohol-related. There is a plausible relationship between ASAP enforcement and public information efforts and the decline in fatal alcohol-related crashes. ASAP activities which contributed to such changes included a more than threefold increase in the number of arrests made annually in the state for driving while intoxicated (DWI), replacement of blood testing with breath testing for evidentiary purposes in DWI arrests, and the training of more than 500 police in DWI enforcement techniques and Breathalyzer operation. In addition, a comprehensive case handling system was established for persons convicted of DWI involving court referral, diagnosis, short-term rehabilitation, and possible follow-up treatments. A large-scale public information program was conducted which produced measurable changes in public knowledge and attitudes regarding alcohol-impaired driving. The report includes a fiscal and personnel review, administrative evaluation of the major activities, an index of project reports, plans for activities after ASAP termination, and supplemental information on the ASAP community and accident experience.

by John M. Muir; Robert G. Ulmer  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd., Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
Rept. No. ASAP-Final-report-1977; 1977; 104p  
Subcontracted to Dunlap and Associates, Inc. See also HS-803 144, Technical Summary. Rept. for 1972-1976.  
Availability: Reference copy only

HS-803 142

# NEW HAMPSHIRE ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF ASAP PATROL ACTIVITY

During the five years (1972-1976) of the New Hampshire Alcohol Safety Action Proj. (ASAP), arrests for driving while intoxicated (DWI) reached an annual rate more than triple that

overtime patrols were more cost-effective in terms of patrol man-hours per DWI arrest. Considerable variation was found among the performance of the officers assigned to the team. Those who stopped more vehicles per unit time did not have higher DWI arrest rates. The efficiency of local overtime patrols (man-hours per DWI arrest) was found to be unrelated to various measurable characteristics of the communities in which the patrols were conducted. Arrest levels were also unrelated to the frequency with which vehicles were stopped. Both forms of special patrols had higher compliance rates with chemical testing procedures than did regular patrols. Special patrols also tended to make arrests at lower blood alcohol concentrations (BAC's) than did regular patrols. Young male drivers are overrepresented among those arrested for DWI, in comparison to their numbers in the licensed driver population. They tend to be arrested later in the evening, to be at a lower BAC, and to be more compliant with chemical testing than are older arrested drivers.

by Robert G. Ulmer; Harold H. Jacobs  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd.,  
Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland  
Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
1977; 39p  
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HS-803 143

#### **NEW HAMPSHIRE ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF THE ADJUDICATION OF ALCOHOL RELATED TRAFFIC ARRESTS**

During the five years (1972-1976) of operation of the New Hampshire Alcohol Safety Action Proj. (ASAP), the almost fourfold increase in arrests for driving while intoxicated (DWI) did not adversely affect the adjudication of such cases. For example, 89% of those arrested and arraigned as first offenders in 1976 were found guilty, the same rate as occurred in 1971. Most DWI cases were adjudicated within about one month of the arrest, a time span which has remained relatively stable despite the increased caseload. Of 8578 persons arrested in 1976 for DWI, 1090 had blood alcohol concentrations (BAC's) below .10% and were not arraigned. Of the remainder, 6789 had been adjudicated as of Apr 1977 while the rest (699) were outstanding. Of the 6300 persons charged as first offenders, 31% contested the case, a rate which remained essentially the same over the years. Of the 89% of the first offenders who were found guilty, just under 10% appealed. The average fine in 1976 first offense cases was \$160, a figure which has gradually increased over the years. The most common license revocation period was 60 days, followed by a variable length revocation associated with court referral to ASAP. Comparisons of the individual courts in the system showed variation in first-offense conviction rates from 66%-

Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
1977; 29p

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Availability: Reference copy only

HS-803 144

#### **NEW HAMPSHIRE ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. TECHNICAL SUMMARY**

by John M. Muir; Robert G. Ulmer  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd.,  
Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland  
Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
1977; 19p

Subcontracted to Dunlap and Associates, Inc. For abstract see  
complete final report, HS-803 141.  
Availability: Reference copy only

HS-803 145

#### **NEW HAMPSHIRE ALCOHOL SAFETY ACTION PROJECT. FINAL REPORT. ANALYSIS OF THE EFFECTIVENESS OF DRIVER RETRAINING SCHOOLS**

The rehabilitation activities of the New Hampshire Alcohol Safety Action Proj. (ASAP) provided referral, screening, and a Driver Retraining School for modifying the drinking/driving behavior of individuals convicted of driving while intoxicated. Two studies using random assignment of subjects measured the effectiveness of the process. In the first study, 500 driving while intoxicated (DWI) offenders were assigned to the Driver Retraining School and 500 DWI offenders were given no treatment and served as controls. The second study, part of a national Short-Term Rehabilitation study, involved 101 problem drinkers in the assigned group and 101 problem drinkers in the control group. There were no major differences between the comparison groups in the primary traffic safety measures of DWI recidivism and subsequent accidents. However, problem drinkers with initial BAC's of .20% and over who were assigned to the Driver Retraining School had fewer subsequent DWI's than an equivalent control group. Problem drinkers who were in the assigned group reported greater social interaction and more control over their drinking, but this latter effect diminished after one year.

by Harold H. Jacobs; Robert G. Ulmer  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd.,  
Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland  
Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
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HS-803 146

**NEW HAMPSHIRE ALCOHOL SAFETY ACTION  
PROJECT. FINAL REPORT. ANALYSIS OF  
OVERALL PROJECT IMPACT**

During the five years (1972-1976) of operation of the New Hampshire Alcohol Safety Action Proj. (ASAP), fatal and injury-producing motor vehicle accidents declined in number by significant amounts as compared with prior years. These reduced accident levels represent a departure from the trend that existed in the state for at least ten years prior to ASAP. Examination of various subsets of accidents show a tendency toward, or statistical confirmation of, the view that the declines have occurred in the classes of accidents most likely to be alcohol-related. Examination of alternate explanations for the noted accident declines discount changes in exposure, energy and speed policies, and economic and other global conditions as possible factors. It has been suggested that ASAP enforcement and public information efforts have created a deterrent effect that modified the drunk/driving behavior of a segment of the at-risk population; this modification has led to fewer traffic accidents taking place.

by Robert G. Ulmer; Harold H. Jacobs  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd.,  
Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland  
Drive, Darien, Conn. 06820  
Contract DOT-HS-055-1-071  
1977; 73p  
Subcontracted to Dunlap and Associates, Inc.  
Availability: Reference copy only

HS-803 147

**NEW HAMPSHIRE ALCOHOL SAFETY ACTION  
PROJECT. FINAL REPORT. REHABILITATING  
DRINKING DRIVERS: AN ANALYSIS OF THREE  
YEARS OF ACTIVITIES OF THE NEW HAMPSHIRE  
ALCOHOL SAFETY ACTION PROJECT**

The New Hampshire Alcohol Safety Action Proj. (ASAP) provided those who were convicted of driving while intoxicated (DWI) with retraining and resources for dealing with problems related to drinking and driving. From mid-1972 through mid-1973, 4388 people were referred for screening to determine their eligibility to attend the Driver Retraining Schools. Of those referred, 2160 people were selected and 1817 were eventually graduated from the schools during the period. To evaluate the program's effectiveness, the subsequent accident involvement and DWI rearrest records of those referred were compared with groups of persons not so referred. The total number of subsequent accidents and DWI rearrests were less for the referred groups than they were for the nonreferred groups. The differences that were found occurred within the same and subsequent year after conviction but were not present in later years. Because of possible differences that may have existed between the groups initially, these findings are not conclusive but do indicate that rehabilitation can reduce the incidence of subsequent accidents and DWI rear-

rests. The cost of processing an individual who attended the Driver Retraining School was \$69.57.

by Harold H. Jacobs; Robert G. Ulmer  
New Hampshire Alcohol Safety Action Proj., 105 Loudon Rd.,  
Concord, N.H. 03301; Dunlap and Associates, Inc., 1 Parkland  
Drive, Darien, Conn. 06820  
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1977; 31p  
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Dunlap and Associates, Inc., Western Div., 7765 Girard Ave., LaJolla, Calif. 92037

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Center for the Environment and Man, Inc., 275 Windsor St., Hartford, Conn. 06120

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Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221

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Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003

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Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142; Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. 02139

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Society for Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pa. 15096; Bolt, Beranek and Newman Inc., 50 Mounton St., Cambridge, Mass. 02138

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Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221

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Urban Inst., 2100 M St., N.W., Washington, D.C. 20037

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SAE-AE-6	HS-022 158	SAE-770139	HS-021 976
SAE-P-71	HS-022 038	SAE-770140	HS-021 977
SAE-SP-423	HS-022 130	SAE-770143	HS-021 978
SAE-770099	HS-021 917	SAE-770144	HS-021 979
SAE-770103	HS-021 956	SAE-770145	HS-021 980
SAE-770108	HS-021 957	SAE-770146	HS-021 981
SAE-770110	HS-021 958	SAE-770147	HS-021 982
SAE-770111	HS-021 959	SAE-770148	HS-021 983
SAE-770112	HS-021 960	SAE-770149	HS-021 984
SAE-770113	HS-021 961	SAE-770380	HS-021 985
SAE-770114	HS-021 962	SAE-770381	HS-021 986
SAE-770115	HS-021 963	SAE-770382	HS-021 987
SAE-770116	HS-021 964	SAE-770590	HS-022 039
SAE-770117	HS-021 965	SAE-770591	HS-022 040
SAE-770120	HS-021 966	SAE-770592	HS-022 041
SAE-770122	HS-021 967	SAE-770593	HS-022 042
SAE-770123	HS-021 968	SAE-770594	HS-022 043
SAE-770124	HS-021 969	SAE-770596	HS-022 044

SAE-770598	HS-022 045	TRRL-LR-762	HS-022 149
SAE-770599	HS-022 046	TRRL-SR-262	HS-022 165
SAE-770600	HS-022 047	UK-766-Vol-1	HS-022 166
SAE-770601	HS-022 048	UMTA-MA-06-0048-77-3	HS-802 631
SAE-770602	HS-022 049	UMTA-MA-06-0049-77-8	HS-022 100
SAE-770603	HS-022 050	VHTRC-78-R19	HS-022 170
SAE-770604	HS-022 051	VTI-100A	HS-022 013
SAE-770605	HS-022 052	ZM-5763-V-8	HS-022 169
SAE-770606	HS-022 053	ZM-5947-T	HS-803 057
SAE-770607	HS-022 054	ZM-6043-7-1	HS-022 129
SAE-770608	HS-022 055	ZT-5561-V-26	HS-022 015
SAE-770609	HS-022 056	5039-01	HS-803 037
SAE-770610	HS-022 057		HS-021 999
SAE-770611	HS-022 058		
SAE-770612	HS-022 059		
SAE-770613	HS-022 060		
SAE-770614	HS-022 061		
SAE-770798	HS-022 062		
SAE-770858	HS-022 002		
SAE-770890	HS-022 000		
SAE-770915	HS-022 001		
SASI-77-401	HS-021 783		
TC-76-031	HS-022 131		
TC-77-014	HS-802 889		
	HS-802 890		



## CONTRACTS AWARDED

DOT-HS-8-01878

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. el a

State of Ohio, Department of Highway Safety, 240 Parsons Avenue, Columbus, Ohio 43205  
\$69,066.00  
To be completed by 31 Dec 80.

DOT-HS-8-01880

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports0 an

State of Nebraska, Department of Motor Vehicles, Statehouse Station, P.O. Box 94759, Lincoln, Nebraska 68509  
\$38,234.00  
To be completed by 31 Dec 80.

DOT-HS-8-01881

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. 0aly

State of Delaware, Division of State Police, P.O. Box 430, Dover, Delaware 19901  
\$3,621.00  
To be completed by 31 Dec 80.

DOT-HS-8-01882

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality:

gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. 0 an

State of Utah, Department of Public Safety, Room 317, State Office Building, Salt Lake City, Utah 84111  
\$82,873.00  
To be completed by 31 Dec 80.

DOT-HS-8-01883

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. 0d;

Commonwealth of Virginia, Department of State Police, Richmond, Virginia 23261  
\$53,208.84  
To be completed by 31 Dec 80.

DOT-HS-8-01886 Mod. 3

**TEST AND EVALUATION OF FUEL SYSTEM INTEGRITY IN REAR IMPACT COLLISION**

Modifications shall be made to Task 2 under Phase 1 of the test program involving 15 car-to-car crash tests. The performance of matrix test numbers 13 and 15, full-sized vehicle/full-sized vehicle, shall be deleted. The full-sized vehicles, six (6) 1971 selected vehicle models, available from previous modifications of conditions in matrix test numbers 3 and 6, and from the cancellation of matrix test numbers 13 and 15, shall be equipped to serve as striking vehicles meeting the general and specific guidelines and requirements of the basic contract. Six (6) selected vehicle models shall be purchased to be utilized as stationary vehicles in the specified collision testing-0m t

Dynamic Science, Inc., A Subsidiary of Talley Industries, 1850 West Pinnacle Peak Road, Phoenix, Arizona 85027  
No change  
No change

DOT-HS-8-01892

**FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided,

problem areas identified, quality control probed, and new developments analyzed; and submit reports.0 sh

State of Texas, Department of Public Safety, 5805 North Lamar Blvd., Austin, Texas 78773  
\$28,592.00

To be completed by 31 Dec 80.

DOT-HS-8-01893

#### MEASUREMENT OF HEAD ACCELERATIONS OF BOXERS--FEASIBILITY STUDY

The feasibility of obtaining reliable and statistically meaningful data based on the measurement of head accelerations of boxers for developing relationships between impact-induced decelerations and concussion shall be determined. The following issues will be addressed: the proper selection of test subjects, to simulate a broad cross section of the driving public; the identification and selection of test locations; an experimental design to ensure a statistically reliable result; and determination of legal restrictions and assessments of liability to the Government, the performing agency and the participants and their agents. A plan shall be developed for a two-phase experimental program, the initial phase of which will consist of a limited series of tests conducted with human subjects assuming this study demonstrates the feasibility of the suggested approach. The results and conclusions of the preliminary experiments will be utilized to modify the full-scale experimental plan so that strict conformance to experimental guidelines can be maintained. The subsequent phase of the experimental program will consist of full-scale, in-site experiments performed at all selected test locations.

Science Applications, Inc., 1200 Prospect Street, La Jolla, California 92037  
\$93,855.00

To be completed eight (8) months from date of contract award (17 Mar 78).

DOT-HS-8-01905

#### DEVELOPMENT OF COMPLIANCE TEST FOR TRUCK REAR UNDERRIDE PROTECTION

A dynamic compliance test procedure shall be developed and a test device now under development shall be validated in order to allow accurate and consistent evaluation of truck rear underride protection. This study will be coordinated with a Federal Highway Administration (FHWA)/Bureau of Motor Carrier Safety (BMCS) program which is concerned with obtaining data on rear underride and with developing feasible rear underride guard designs. The objectives of this study are as follows: develop a dynamic compliance test procedure for truck/trailer rear underride protection; through the above test procedure, validate the load-cell, moving-barrier test device presently under development by the National Highway Traffic Safety Administration (NHTSA); develop a truck body simulator to effectively model the rear of truck/trailer body during dynamic testing; evaluate the two best previously developed rear underride guards as to their effectiveness in protecting occupants in rear and rear-offset collisions with a truck/trailer; develop a static compliance test procedure for truck/trailer rear underride protection; assess the production feasibility of specified rear underride guards; and coordinate all efforts with

the FHWA/MCS program on feasible underride guard design to enhance the effectiveness of each program. con

Dynamic Science, Inc., 1850 West Pinnacle Peak Road, Phoenix, Arizona 85027  
\$381,140.00

DOT-HS-8-01915

#### STANDARDS ENFORCEMENT TEST PROGRAM FY '78; FMVSS NO. 117 "RETREADED PNEUMATIC TIRES--PASSENGER CARS" (CASING INSPECTION, TREAD PEEL BACK, PHASE D)

Passenger car tires shall be inspected and tested in accordance with FMVSS No. 117, Retreaded Pneumatic Tires--Passenger Cars, following the National Highway Traffic Safety Administration's (NHTSA) Office of Standards Enforcement (OSE) Laboratory Test Procedure TP-117D-02 dated January 27, 1977. 0his

Smithers Scientific Services, Inc., 425 W. Market Street, Akron, Ohio 44303  
Per Delivery Order

To be completed one (1) year from date of contract award (22 Mar 78).

DOT-HS-8-01916

#### STANDARDS ENFORCEMENT TEST PROGRAM FY '78; FMVSS NO. 117 "RETREADED PNEUMATIC TIRES--PASSENGER CARS" (CASING INSPECTION, TREAD PEEL BACK, PHASE D)

Passenger car tires shall be inspected and tested in accordance with FMVSS No. 117, Retreaded Pneumatic Tires--Passenger Cars, following the National Highway Traffic Safety Administration's (NHTSA) Office of Standards Enforcement (OSE) Laboratory Test Procedure TP-117D-02 dated January 27, 1977. 0ry

Dayton T. Brown, Inc., Church Street, Bohemia, New York 11716  
Per Delivery Order

To be completed one (1) year from date of contract award (22 Mar 78).

DOT-HS-8-01925

#### TIRE TREADWEAR TEST - EFFECT OF COURSE SEVERITY ON TREAD LIFE AND EFFECT OF TIRE CONSTRUCTION ON FUEL ECONOMY

There shall be established two tire test courses using the Safety Research Laboratory's (SRL) instrumented vehicle to determine the lateral and longitudinal accelerations and to design the test courses with characteristics similar to the Uniform Tire Quality Grading Test Center course at San Angelo, Texas. These courses will be used to measure the actual performance of the course monitoring tires (CMT), and the ef-

HODGES TRANSPORTATION, INC., Nevada Automotive Test Center, Post Office Box 234, Carson City, Nevada 89701 \$48,902.40  
To be completed three (3) months from date of contract award (23 Mar 78).

DOT-HS-8-01926

**COMPLIANCE TESTING OF "NEW PNEUMATIC TIRES--PASSENGER CARS"**

New pneumatic passenger car tires shall be tested in accordance with FMVSS No. 109 (National Highway Traffic Safety Administration's (NHTSA) Office of Standards Enforcement (OSE) Laboratory Test Procedure TP-109-04 dated April 1, 1974). Bead unseat--strength and physical dimensions, endurance, and high-speed tests will be conducted.

Dayton R. Brown, Inc., Church Street, Bohemia, New York 11716  
Per Delivery Order  
To be completed one (1) year from date of contract award (24 Mar 78).

DOT-HS-8-01927

**COMPLIANCE TESTING OF "NEW PNEUMATIC TIRES--PASSENGER CARS"**

New pneumatic passenger car tires shall be tested in accordance with FMVSS No. 109 (National Highway Traffic Safety Administration's (NHTSA) Office of Standards Enforcement (OSE) Laboratory Test Procedure TP-109-04 dated April 1, 1974). Bead unseat--strength and physical dimensions, endurance, and high-speed tests will be conducted.

Smithers Scientific Services, Inc., 425 West Market Street, Akron, Ohio 44303  
Per Delivery Order  
To be completed one (1) year from date of contract award (24 Mar 78).

DOT-HS-8-01928

**TECHNICAL (ENFORCEMENT) ASSISTANCE TO STATE'S 55 MPH PROGRAM--BASIC ORDERING AGREEMENT, TIME AND MATERIALS**

Enforcement technical assistance shall be provided to state enforcement agencies in their efforts to achieve a higher degree of compliance with their 55-mph speed limit. Technical assistance will involve on-site visits to state enforcement agencies, upon request, to observe, evaluate and make recommendations to improve enforcement strategies and tactics.

International Association of Chiefs of Police, Inc., Eleven Firstfield Road, Gaithersburg, Maryland 20760 \$55,756.00  
To be completed one (1) year from date of contract award (31 Mar 78).

A dynamometer test shall be performed on a vehicle's air brake system that has previously resulted in a FMVSS No. 121 test failure. This is a test to demonstrate the failure mode and will be conducted with representatives of the National Highway Traffic Safety Administration (NHTSA) and the vehicle manufacturer present.

Greening Testing Labs., Inc., 19465 Mt. Elliot Avenue, Detroit, Michigan 48234  
Increased \$520.00  
No change

DOT-HS-6-01403 Mod. 4

**INFLUENCE OF AERODYNAMIC DISTURBANCES ON VEHICLE HANDLING**

Eight (8) wind generation covers, to be fabricated in accordance with quotation and specification submitted by A and R Tarpaulls, shall be purchased. wit

Systems Technology, Inc., 13766 South Hawthorne Blvd., Hawthorne, California 90250  
Increased \$2,853.00  
Extended through 30 Jun 78.

DOT-HS-6-01478 Mod. 10

**STANDARD ENFORCEMENT TESTING PROGRAM TESTING OF PASSENGER VEHICLES FOR COMPLIANCE WITH FMVSS NOS. 219 AND 301-75**

On each of ten (10) crash tests using a selected vehicle model for each test, the following data shall be obtained on the two (2) front-seated dummies: head and chest acceleration in accordance with FMVSS No. 208, femur forces acceleration in accordance with FMVSS No. 208, upper shoulder belt loads, and pretest dummy positions. For each of the vehicle crash tests the following steering column and related data shall also be provided: amount of steering column collapse, and 16 mm motion picture coverage of the action of the driver's head in relation to the steering column during the crash event. Following completion of the tests, one (1) seat-belt retractor system shall be removed from each vehicle and forwarded to the contract technical manager.

Dynamic Science, Inc., 1850 West Pinnacle Peak Road, Phoenix, Arizona 85027  
Increased \$23,660.00  
No change

DOT-HS-7-01477 Mod. 9

**TESTING OF PASSENGER VEHICLE FOR COMPLIANCE TESTING**

On each of 35 vehicle crash tests, the following data shall be obtained on the two (2) front-seated dummies: head and chest acceleration in accordance with FMVSS No. 208, femur forces in accordance with FMVSS No. 208, upper shoulder belt



tion picture coverage of the driver's head in relation to the steering column during the crash event as well as the occupant's head action. Following completion of the tests, one (1) seat-belt retractor system shall be removed from each vehicle and forwarded to the contract technical manager.

Approved Engineering Test Labs., 1536 East Valencia Drive,  
Post Office Box 4158, Fullerton, California 92631  
\$118,125.00  
No change

DOT-HS-7-01552 Mod. 9

#### RESEARCH SAFETY VEHICLE

A research safety vehicle (RSV) shall be developed in which the high technology systems developed and the baseline safety systems refined in Phase 3a will be integrated. The high technology systems are as follows: turbo-charged engine of a selected small vehicle model, an automated manual transmission, and the control microprocessor; radar system for headway control and hazard detection; alpha-numeric display (on instrument panel); and anti-skid braking system with collision mitigation provisions.

Minicars, Inc., 35 La Patera Lane, Goleta, California 93017  
Increased \$81,500.00  
No change

DOT-HS-7-01706 Mod. 1

#### NATIONAL ACCIDENT SAMPLING SYSTEM DESIGN, PHASES 2 AND 3

Task 5 (Special Sampling Frames) shall be deleted and Task 9 (Pilot Test Analysis) shall be added. The objective of the pilot study is to determine the feasibility of the concept of the National Accident Sampling System (NASS), i.e., small teams of accident investigators located at randomly selected sites collecting data which can be used to produce accurate national estimates of safety characteristics. More specific goals of the pilot tests are the establishment of the ten (10) teams at randomly selected sites, the training of the team members to collect the necessary data, the estimation of the effect of team size on the quantity and quality of data collection, and the acquisition of more information on the within-PSU (primary sampling unit) variability. An analysis of the pilot study data collection should include a discussion of the performance of each of these goals. 0err

Westat, Inc., 11600 Nebel Street, Rockville, Maryland 20852  
Increased \$39,638.00  
Extended through 30 Sep 79.

formance between new condition (OE, original equipment) springs and sagging (OE) springs shall be defined, and the effects on vehicle handling performance brought on by the usage of spring spacers to correct spring sag shall be determined. Octe

Systems Technology, Inc., 13766 S. Hawthorne Blvd.,  
Hawthorne, California 92050  
Increased \$28,214.00  
Extended to 31 Mar 79.

DOT-HS-8-01809

#### SMALL CAR FRONT-SEAT PASSENGER INFLATABLE RESTRAINT SYSTEM

An evaluation shall be made of a small car front-seat passenger inflatable restraint system to demonstrate that current production-type air cushion restraint systems, using essentially "off-the-shelf" units, are capable of providing a minimum of 30 mph barrier equivalent velocity (BEV) protection to the front-seat passengers of small vehicles. The inflator used will be of the solid propellant type. An inflatable knee restraint will be provided integral with the air bag. The air bag system will be of the low mount type. Three (3) types of vehicles will be studied, in weights varying from approximately 2,000 to 3,000 pounds siz

Minicars, Inc., 35 La Patera Lane, Goleta, California 93017  
\$378,128.00  
To be completed by 30 Apr 79.

DOT-HS-8-01864 Mod. 1

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. sys

State of Alabama, Alabama Dept. of Public Safety, Post  
Office Box 1511, Montgomery, Alabama 36130  
\$124,390.68  
To be completed by 31 Dec 80.

DOT-HS-8-01877 Mod. 1

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided,

Nashville, Tennessee 37219  
\$93,661.00  
To be completed by 31 Dec 80.

DOT-HS-8-01908IA

## **INJURY REPORTING SYSTEM**

Pilot studies shall be conducted to test the feasibility of collecting additional data elements from the hospital emergency rooms comprising the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS), which will be of special interest to the National Highway Traffic Safety Administration (NHTSA) in making national estimates of the number of motor-vehicle-related injuries treated in hospital emergency rooms throughout the United States. and

Consumer Product Safety Commission, 5401 West Bard Avenue, Bethesda, Maryland 20207  
\$400,000.00  
To be completed by 30 Sep 79.

DOT-HS-8-01912

## **AN INDEPENDENT ASSESSMENT OF THE THREE-WAY CATALYST**

A three-way catalyst system shall be installed in two (2) American-made passenger cars, with specifications typical of those projected for a vehicle manufactured during the period 1981-1984; and the durability of the emissions control system shall be determined over the standard EPA (Environmental Protection Agency) certification course of 50,000 miles (total mileage to be accumulated on the two (2) vehicles).0cs.

Citizens For Clean Air, Inc., 32 Broadway, Room 1109, New York, New York 10004  
\$233,597.00  
To be completed eight (8) months from date of contract award (28 Apr 78).

DOT-HS-8-01920

## **BASIC ORDERING AGREEMENT (TIME AND MATERIALS) WITH TASK ORDERS, FOR INSPECTION AND TESTING SERVICES OF MOTOR VEHICLE EQUIPMENT**

In conjunction with the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI), quick reaction/response inspection and testing of motor vehicles or motor vehicle equipment shall be performed in the following areas: metallurgical analysis; component testing (environmental, load, fatigue, etc.); stress and/or failure analysis; vehicle handling and dynamic testing; vehicle crash testing (car to car or car to barrier); gas concentration measurements including CO (carbon monoxide), NOx (nitrogen oxides), gasoline vapor and toxic agents; component failure simulation;

Per Task Order  
To be completed one (1) year from date of contract award (28 Mar 78).

DOT-HS-8-01921

## **BASIC ORDERING AGREEMENT (TIME AND MATERIALS) WITH TASK ORDERS, FOR INSPECTION AND TESTING SERVICES OF MOTOR VEHICLE EQUIPMENT**

In conjunction with the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI), quick reaction/response inspection and testing of motor vehicles or motor vehicle equipment shall be performed in the following areas: metallurgical analysis; component testing (environmental, load, fatigue, etc.); stress and/or failure analysis; vehicle handling and dynamic testing; vehicle crash testing (car to car or car to barrier); gas concentration measurements including CO (carbon monoxide), NOx (nitrogen oxides), gasoline vapor and toxic agents; component failure simulation; tire/wheel failure analysis; and restraint system failure analysis.0ail

Value Engineering Company, 2550 Huntingdon Avenue, Fairfax County, Alexandria, Virginia 22303  
Per Task Order  
To be completed one (1) year from date of contract award (28 Mar 78).

DOT-HS-8-01923

## **BASIC ORDERING AGREEMENT (TIME AND MATERIALS) WITH TASK ORDERS, FOR INSPECTION AND TESTING SERVICES OF MOTOR VEHICLE EQUIPMENT**

In conjunction with the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI), quick reaction/response inspection and testing of motor vehicles or motor vehicle equipment shall be performed in the following areas: metallurgical analysis; component testing (environmental, load, fatigue, etc.); stress and/or failure analysis; vehicle handling and dynamic testing; vehicle crash testing (car to car or car to barrier); gas concentration measurements including CO (carbon monoxide), NOx (nitrogen oxides), gasoline vapor and toxic agents; component failure simulation; tire/wheel failure analysis; and restraint system failure analysis.

General Environments Corp., 6840 Industrial Road, Springfield, Virginia 22151  
Per Task Order  
To be completed one (1) year from date of contract award (28 Mar 78).

DOT-HS-5-01056 Mod. 15

**ANNUAL VEHICLE REPAIR COSTS ANALYSIS**

A comparison shall be made concerning the repair costs for vehicles in a DMVI (Department of Motor Vehicles Inspection) program and the repair costs for vehicles outside such a program. For the non-DMVI environment, two repair cost histories (Life Cycle Costs) will be established. The first history will be for the (overly?) prudent driver; the second history will be for the so-called average driver as represented by those participants in the Auto Check program prior to their enrollment. For the DMVI environment, the repair and maintenance cost data from the 291 participants who had four or more periodic inspections will be used.

State of Alabama, Executive Department, Office of Highway and Traffic Safety, Montgomery, Alabama 36104

No change

Extended to 17 Mar 78.

DOT-HS-6-01365 Task Order 1 Mod. 1

**MULTIVARIATE MODELING AND ANALYSIS**

Tasks 1 through 4 are modified to read as follows: "Adaptronics will examine the structure of a data base consisting of single-accelerator measurements of head motion for 18 experiments with primates, approximate AIS (Abbreviated Injury Scale) values for a subset of the experiments, and, for the same subset, estimated temporal distributions of recovery of the animals." Additional subtasks and tasks shall be to construct a parametric plot of equal AIS contours, illustrate the plot differences, synthesize brain injury predictive models, and prepare a final technical report. 001

Adaptronics, Inc., Westgate Research Park, 7700 Old Springhouse Road, McLean, Virginia 22101

Increased \$1,997.06.

To be completed twenty-one (21) days from date of contract modification (15 Feb 78)

DOT-HS-7-01502 Mod. 2

**OLDER DRIVER LICENSING AND IMPROVEMENT SYSTEMS**

Current tasks 4 through 13 in Phases 1 and 2 shall be deleted. The following tasks shall be performed in their place: listing of data needs; determination of data mechanisms; determination of the feasibility of utilizing the data mechanisms; designing of a data management plan; data collection and analysis; definition of older driver licensing and improvement system; specification of requirements for performance skills testing procedures; preparation of a test validation plan; and preparation of a driver license administrator's guidebook for older drivers. 01e

Dunlap and Associates, Inc., One Parkland Drive, Darien, Connecticut 06820

No change

Extended to 15 Mar 79.

DOT-HS-7-01511 Mod. 3

**RESEARCH INPUT FOR COMPUTER SIMULATION OF AUTOMOBILE COLLISIONS**

For the seven (7) side-impact tests, striking-vehicle accelerometers and struck-vehicle accelerometers shall be provided for the struck vehicle as done for Contract DOT-HS-4-00922. The camera mounting should not be heavy enough to influence the trajectory or crush characteristics of the struck vehicle. A velocity-vs-time graph shall be prepared for the seven (7) side-impact crashes per method shown in Figures 18 and 19 in SAE-740580, pla

Calspan Corporation, 4455 Genesee Street (Erie County), Buffalo, New York 14221

Increased \$14,950.00

Extended to 31 Jul 78.

DOT-HS-7-01530 Mod. 3

**DRUG RESEARCH METHODOLOGY**

The workshop site shall be changed from Ann Arbor, Michigan to Washington, D.C., and the number of non-Government workshop participants shall be increased from five (5) to seven (7). The literature search activity shall be continued for the extended contract period.

The Regents of the University of Michigan, 260 Research Administration Building, The University of Michigan, Ann Arbor, Michigan 48104

Increased \$43,783.00

Extended to 30 Jun 78.

DOT-HS-7-01679 Mod. 1

**DEVELOPMENT AND EVALUATION OF A BELT RESTRAINT**

The preloading feature and passive restraint conditions such as slack and steering wheel and knee bumper collapse shall be considered in the computer work, and a different vehicle model buck shall be used for the sled tests. The fabrication of a number of passive restraint belt systems for comprehensive performance tests shall not be undertaken.

Calspan Corporation, 4455 Genesee Street, Buffalo, New York 14221

No change

No change

DOT-HS-7-01763 Mod. 2

**EVALUATION/ASSESSMENT SYSTEM DEVELOPMENT AND DEMONSTRATION**

A system for planning, programming, and evaluating a state's 402 program shall be developed. The management cycle shall consist of planning, programming, implementation, monitoring/assessment, and evaluation. A handbook covering the planning, programming, and evaluation phases of a state's highway safety program, and an annual report for the State at

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. 0 pr

Metropolitan Police Department, District of Columbia, 300 Indiana Avenue, N.W., Washington, D.C. 20001  
\$16,895.41

To be completed by 31 Dec 80.

DOT-HS-8-01832

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of South Dakota, Department of Highway Safety, 118 West Capitol, Pierre, South Dakota 57501  
\$31,271.31

To be completed by 31 Dec 80.

DOT-HS-8-01836

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. 0 pr

State of New York, Department of Motor Vehicles, South Mall, Swan Street Building, Albany, New York 12228  
\$209,922.00

To be completed by 31 Dec 80.

gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Wyoming, Wyoming Highway Department, Post Office Box 1708, Cheyenne, Wyoming 82001  
\$71,211.98

To be completed by 31 Dec 80.

DOT-HS-8-01838

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Wisconsin, Department of Transportation Division of Motor Vehicles -- Accident Data, P.O. Box 7917, Madison, Wisconsin 53707  
\$57,900.00

To be completed by 31 Dec 80.

DOT-HS-8-01839

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Iowa, Department of Transportation, Office of Safety Programs, 5268 N.W. Second Avenue, Des Moines, Iowa 50313  
\$45,202.00

To be completed by 31 Dec 80.

DOT-HS-8-01840

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic ac-

Complex, Carson City, Nevada 89710  
\$57,920.00  
To be completed by 31 Dec 80.

DOT-HS-8-01841

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. 0it

State of Kansas, Department of Transportation Safety Dept.,  
State Office Building, Topeka, Kansas 66612  
\$61,570.00

To be completed by 31 Dec 80.

DOT-HS-8-01842

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. 0it

State of Minnesota, Department of Public Safety, 211  
Transportation Building, St. Paul, Minnesota 55155  
\$68,731.00

To be completed by 31 Dec 80.

DOT-HS-8-01844

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. 0it

State of North Dakota, Capitol Grounds-Governor's Hwy.  
Safety Representative, Bismarck, North Dakota 58505  
\$20,760.00

To be completed by 31 Dec 80.

Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. epo

State of Indiana, Department of Traffic Safety and Vehicle Inspection, 215 North Senate Avenue, Indianapolis, Indiana 46202

\$84,394.00

To be completed by 31 Dec 80.

DOT-HS-8-01847

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. edj

State of Maine, Department of State Motor Vehicle Division,  
1 Child Street, Augusta, Maine 04333  
\$35,898.00

To be completed by 31 Dec 80.

DOT-HS-8-01848

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided; problem areas identified; quality control probed; and new developments analyzed; and submit reports. 0ini

State of West Virginia, Criminal Justice and Hwy. Safety Div.,  
Morris Square, Suite 321, 1212 Lewis Street, Charleston, West Virginia 25301  
\$57,802.80

To be completed by 31 Dec 80.

DOT-HS-8-01849

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic ac-

State of New Hampshire, Department of Safety, James H. Hayes Safety Building, Hazen Drive, Concord, New Hampshire 03301  
\$17,579.00  
To be completed by 31 Dec 80.

DOT-HS-8-01852

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Missouri, Missouri Division of Highway Safety, 2634 Industrial Drive, Jefferson City, Missouri 65101  
\$169,977.00

To be completed by 31 Dec 80.

DOT-HS-8-01854

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Vermont, Governor's Highway Safety Program, Agency of Transportation, Montpelier, Vermont 05602  
\$9,727.60

To be completed by 31 Dec 80.

DOT-HS-8-01855

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Illinois, Department of Transportation, 2300 South Dirksen Building, Springfield, Illinois 62764  
\$165,484.00

To be completed by 31 Dec 80.

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of California, Office of Traffic Safety, P.O. Box 865, Sacramento, California 95804  
\$423,183.00

To be completed by 31 Dec 80.

DOT-HS-8-01863

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Report System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Michigan, Department of State Police, Office of Highway Safety Planning, 7150 Harris Drive, Lansing, Michigan 48913  
\$220,810.00

To be completed by 31 Dec 80.

DOT-HS-8-01865

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Montana, Highway Traffic Safety Division, DCA, Capitol Station, Helena, Montana 59601  
\$56,512.00

To be completed by 31 Dec 80.

DOT-HS-8-01868

#### FATAL ACCIDENT REPORTING SYSTEM (FARS)

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided,

and Maryland 21031  
\$96,733.00  
To be completed by 31 Dec 80.

DOT-HS-8-01869

#### **FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. dev

State of New Jersey, Office of Highway Safety, 4 Scotch Road, Trenton, New Jersey 08628  
\$90,108.00

To be completed by 31 Dec 80.

DOT-HS-8-01870

#### **FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports

Commonwealth of Massachusetts, Governor's Highway Safety Bureau, 50 Staniford Street, Boston, Massachusetts 02114  
\$165,125.99

To be completed by 31 Dec 80

DOT-HS-8-01871

#### **FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Connecticut, Department of Motor Vehicles, 60 State Street, Wethersfield, Connecticut 06109  
\$95,053.00

To be completed by 31 Dec 80.

Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports. Orts

Commonwealth of Puerto Rico, Puerto Rico Traffic Safety Commission, Box F1, Santurce, Puerto Rico 00910  
\$48,643.56

To be completed by 31 Dec 80.

DOT-HS-8-01874

#### **FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.

State of Hawaii, Department of Transportation, Motor Vehicle Safety Office, 869 Punchbowl Street, Honolulu, Hawaii 96813  
\$66,147.00

To be completed by 31 Dec 80.

DOT-HS-8-01876

#### **FATAL ACCIDENT REPORTING SYSTEM (FARS)**

The following work shall be performed for the Fatal Accident Reporting System (FARS), a national computerized data collection system which contains reports of current data on all motor vehicle traffic accidents in which there is a fatality: gather data; manually code records of each fatal traffic accident; attend conferences where training will be provided, problem areas identified, quality control probed, and new developments analyzed; and submit reports.0 an

State of South Carolina, State Highway Department, P.O. Box 191, Columbia, South Carolina 29202  
\$15,500.00

To be completed by 31 Dec 80.

DOT-HS-8-01924

#### **BASIC ORDERING AGREEMENT (TIME AND MATERIALS) WITH TASK ORDERS, FOR INSPECTION AND TESTING SERVICES OF MOTOR VEHICLE EQUIPMENT**

In conjunction with the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI), quick reaction/response inspection and testing of motor vehicles or motor vehicle equipment shall be performed in the fol-

gasoline vapor and toxic agents; component failure simulation;  
tire/wheel failure analysis; and restraint system failure analysis.nal

ARTECH Corporation, 2816 Fairfax Drive, Falls Church,  
Fairfax County, Virginia 22042  
Per Task Order  
To be completed one (1) year from date of contract award (28  
Mar 78).

DOT-HS-8-01946

#### **ACCIDENT INFORMATION RELATED TO DRIVER VISIBILITY AND MIRRORS**

Accident information related to driver visibility and mirrors  
shall be obtained which will provide additional data to support  
the National Highway Traffic Safety Administration's  
(NHTSA) development of a new standard on Fields of Direct  
View and the preparation of an amendment to FMVSS No.  
111 on rearview mirrors. The objective is to obtain as many  
accident reports as possible from accident investigators in field  
offices throughout the United States. dyn

GAB Business Services, Inc., 4201 Connecticut Avenue,  
N.W., Washington, D.C. 20008  
\$18,527.50  
To be completed sixty (60) days from date of contract award  
(25 Apr 78).

DOT-HS-8-01922

#### **BASIC ORDERING AGREEMENT (TIME AND MATERIALS) WITH TASK ORDERS, FOR INSPECTION AND TESTING SERVICES OF MOTOR VEHICLE EQUIPMENT**

In conjunction with the National Highway Traffic Safety Ad-  
ministration's (NHTSA) Office of Defects Investigation (ODI),  
quick reaction/response inspection and testing of motor vehi-  
cles or motor vehicle equipment shall be performed in the fol-  
lowing areas: metallurgical analysis; component testing  
(environmental, load, fatigue, etc.); stress and/or failure analy-  
sis; vehicle handling and dynamic testing; vehicle crash testing  
(car to car or car to barrier); gas concentration measurements  
including CO (carbon monoxide), NOx (nitrogen oxides),  
gasoline vapor and toxic agents; component failure simulation;  
tire/wheel failure analysis; and restraint system failure analy-  
sis. 0nil

Battelle Memorial Institute, Columbus Lab., 505 King Avenue,  
Columbus, Franklin, Ohio 43201  
Per Task Order  
To be completed one (1) year from date of contract award (28  
Mar 78).



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